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NATIONAL ASSOCIATION
OF

Secondary-School Principals

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THE CONTENTS OF THIS BULLETIN ARE LISTED IN "EDUCATION INDEX"

NATIONAL ASSOCIATION OF SECONDARY-SCHOOL PRINCIPALS

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1952-53

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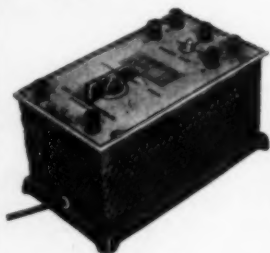
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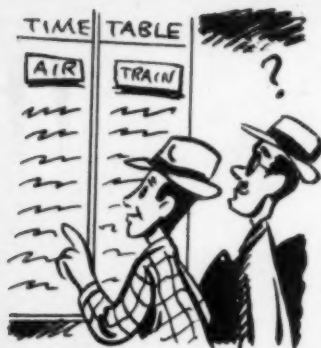
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ASSOCIATION BUSINESS

FOR BUSINESS MEETING at Annual Convention, February 24, 1953
Los Angeles, California

THE Executive Committee of the National Association of Secondary-School Principals has made extensive studies of the present and proposed professional program of the National Association of Secondary-School Principals in relation to the present and probable costs in making effective such professional programs. Although our annual individual membership dues are \$5.00, only a small portion of the members pay at the \$5.00 rate—72.4% (as of June, 1952) of all members enrolled through their State Principals' Associations at \$3.00 per member.

Costs of printing THE BULLETIN, which is sent monthly to all members, increased 45.2% since January, 1948. The actual printing and mailing costs of all the copies of THE BULLETIN for the year 1951-52 was \$3.44 per member. In 1948 it was \$2.32 per member. There are many additional costs in providing professional services to members which are not included in the printing and mailing expense of THE BULLETIN. Many educational organizations have been compelled to increase their annual dues to keep pace with the rising costs of operation.

It is proposed that revised sections of Article III—*Membership*—be adopted at the annual winter convention, February 21-25, 1953, Los Angeles, California, as here stated. Such membership rates would become effective September 1, 1953. Therefore, the Executive Committee recommends that the Constitution, as it applies to membership, be amended as recorded in the following sections of Article III—*Membership*.—THE EXECUTIVE COMMITTEE.

ARTICLE III—*Membership*

SECTION 2. All individuals shall be eligible to active membership who are engaged in administering supervision or teaching secondary education upon payment of the annual fee of \$8.00 to the executive secretary. (Annual fee changed from \$5.00 to \$8.00.)

SECTION 3. Members of state organizations of secondary-school principals shall be eligible to active membership in the National Association of Secondary-School Principals upon payment of the annual fee of \$5.00 through the state secretary or representative. (Changed from \$3.00 to \$5.00.)

SECTION 4. All other persons interested in secondary education shall be eligible to associate membership upon payment of the annual fee of \$8.00 to the executive secretary. (Changed from \$5.00 to \$8.00.)

SECTION 5. Only active members [holding administrative positions in secondary education in schools or state departments of education] shall have the privilege of holding office. (Change includes part included in brackets.)

SECTION 6. Institutional membership shall be open to all secondary schools and libraries and other educational institutions. The annual dues of \$12.00 shall be paid by the educational institution. If institutional membership is obtained through a state secondary-school principals' association, it shall be \$10.00 per year. The principal of a member school shall be credited with a personal participating membership and shall receive all benefits and privileges pertaining thereto. In addition, the school library shall receive a duplicate copy of all proceedings, bulletins, special reports, and a subscription to STUDENT LIFE. The school may also designate any staff representative who shall receive delegate privileges at the annual conventions of the Association. (Change in rates from \$8.00 to \$12.00 and \$6.00 to \$10.00.)

SECTION 7. Any individual eligible to active or associate membership in the National Association of Secondary-School Principals shall have life membership upon payment of the life membership fee of \$150 to the executive secretary. (Change from \$100 to \$150.)

The National Science

Teachers Association

is the largest and most active organization of pre-college science teachers in the world. Originally activated as the Department of Science Instruction at the 1895 meeting of the National Education Association in Denver, Colorado, there was a merger in 1944 with the American Science Teachers Association of the American Association for the Advancement of Science. With renewed hybrid vigor, the new National Science Teachers Association rapidly expanded in membership and membership services; set up a national headquarters office with the National Education Association in 1948; today enrolls over 5,000 individual members, 1,000 school and college library subscriptions.

The Association serves all science teachers but especially those at elementary, secondary, and junior-college levels and in the education of teachers in science. It recognizes no special emphasis, subject, or level as the most important but seeks to aid in the improvement of all aspects of science instruction. It strives to meet a dual responsibility; namely, (1) that of helping to educate all our youth in scientific knowledge, attitudes, and understandings in order that our nation may have a voting population that better understands the role of science, scientists, and engineers in national progress, defense, and the social enterprise of designs for better living; and (2) that of helping to develop scientifically trained personnel sufficient in numbers and competence to insure continued progress of science and technology in the United States.

The goals of the Association are sought through these principal media:

1. The Association journal, *The Science Teacher*—published six times a year and sent to all members and subscribers.
2. *Packets of Teaching Aids for Science*—assembled and mailed four times a year, supplemented by a number of special mailings of individual items; sent to all members and subscribers.
3. Meetings and conventions—three regional meetings held in late June with the NEA and in October and December with the AAAS, plus an annual national convention in late March or early April, provide "close at hand" opportunities for contacts and professional advancement for all members.
4. The Advisory Council on Industry-Science Teaching Relations and a Business-Industry Section—through contacts with educators and scientists in industry and research institutions, NSTA members are better kept abreast of new developments and applications in science and technology.
5. The Future Scientists of America Foundation—an action program embracing five fields of endeavor: science achievement awards for pupils, recognition awards for teachers, work-shops and institutes for teachers, guidance and related services to science pupils, and research in science teaching.

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Planned and Prepared Under the Guidance of the

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NATIONAL SCIENCE TEACHERS ASSOCIATION

A DEPARTMENT OF THE NATIONAL EDUCATION ASSOCIATION

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A Department of Secondary Education of the NATIONAL EDUCATION ASSOCIATION

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THE NATIONAL ASSOCIATION OF SECONDARY-SCHOOL PRINCIPALS

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A Few Words About This Publication

TODAY, boys and girls must be educated to live in an environment made complex through the contributions of scientific research. The impact of this research is affecting trends in education and particularly trends in science education. Evidence of widespread recognition of this impact is to be found in *Planning for American Youth*¹, to which we will return later. Other impacts upon science instruction in the high schools today result from the current and prospective future shortages of scientists, technicians, and engineers; and from the somewhat traditional reluctance of educators and industrialists to work together in interpreting business-industry life—its opportunities, its responsibilities, how it operates, and so on—to boys and girls. These factors and many others imply much work to be done, many gaps to be bridged, a great deal of hard thinking and re-thinking of the science curriculum. All this adds up to a tremendous job which of right ought to be tackled not by science teachers alone but through teamwork, involving science teachers and their colleagues in other fields. It should involve especially their principals, who, after all, are mostly responsible for the implementation of the curriculum and the principles of good teaching.

Hence it is a timely and much appreciated opportunity for the science teachers of the nation to be responsible, through their own professional organization, for this issue of THE BULLETIN of the National Association of Secondary-School Principals.

This publication in a very real sense is a substitute, the best we can conceive, for "sitting down around the table and talking things over." In the included contributions you—the principal of a high school—will find earnest discussions of what the science teachers believe to be the "best" in recommendations for science education to fit today's needs. You will find some veiled (and some not-so-veiled) "gripes" at the attitudes of some high-school principals with respect to science courses and science teachers, and the teachers' urgent pleas for adequate time for the *leisurely* teaching of science through such activities as laboratory work, field trips, and planned, sequential experiences. Let's face the facts of life head on and acknowledge that many science teachers believe, rightly or wrongly, that what is administratively inconvenient, or somewhat more-than-average in cost, all too often automatically becomes administratively impossible. An example out of the writer's experience recalls that during World War II he taught a course in radio for sixteen to twenty eleventh- and twelfth-grade boys for three or four years. At the end of the war, he recommended continuation of the course as an elective and his principal approved. When only thirteen boys signed up for the course the first post-war year, the school board decreed that the rule "no course for fewer than fifteen pupils" be reinstated.

¹ A 64-page booklet available at 50 cents each from the National Association of Secondary-School Principals, 1201 16th Street, N. W., Washington 6, D. C.

How can we balance this decision with the offering of fourth-year Latin for eight pupils simply because "they have all had third-year Latin"? We'd like to have you principals on our team—and batting in the "clean-up position"—in the effort to attain a pattern of science education consistent with the needs and demands of the times and of the days that are to come.

Science teachers believe that a sound and well-planned *program* of science courses in grades seven through twelve can contribute to *all ten* "imperative needs of youth" as outlined in *Planning for American Youth*. Most directly served, of course, is Need No. 6: "All youth need to understand the methods of science, the influence of science on human life, and the main scientific facts of the nature of the world and of man." One man's opinion as to an approximate order of the degrees to which other needs are served by instruction in science would suggest Nos. 1, 10, 2, 9, 5, 7, and 8.

However, we seriously question whether these modern goals of education can be realized short of some *minimum program* of science instruction for *ALL* the pupils in junior and senior high schools. What the minimum is, is a touchy question, of course. Possibly we science people will have to back up a bit from the twelve-year sequence advocated in the Thirty-first Yearbook of the National Society for the Study of Education. But we will not back up so far as to demand less than: (a) for all the pupils, a strong flavoring of science in the elementary-school curriculum; (b) for all the pupils, a strong program of science in the junior high school, including provision for individual or small-group laboratory work; (c) for all boys and girls, a laboratory course in biology at grade nine or ten and a laboratory course in physical science—general or in one special field—at grade ten, eleven, or twelve; and (d) opportunities for talented and science-interested pupils to have courses in the beginning of specialization in chemistry, physics, advanced biology, earth science, radio, and possibly other fields in grades eleven and twelve. Which pupils take what courses, particularly at grades ten and beyond, is an important question for serious consideration by the guidance or counseling staff of a given school, in which connection the science teachers' views should not be ignored.

Now on the matter of *quality* of instruction. Probably no high-school principal can find a satisfying amount of time to give to this segment of his total job. Science is much less favored than a number of other curriculum areas in the degree to which "helping teacher" services are provided by science supervisors or co-ordinators. Again facing the facts of life, it must be admitted that probably a majority of the classroom teachers would vote against such service, a regrettable attitude in the writer's opinion, but, nevertheless, true.

So, what seems to be the answer? "Coasting along" will not produce the stimulating, dynamic kind of science teaching that triggers the interests and imaginations of young people and challenges them to their full potential. In large measure, the professional growth and development of science teachers is a kind of "bootstraps operation." Many such professionally minded teachers

have banded together in organizations as a means of facilitating the exchange of experiences and ideas, discussing common problems of mutual interest, keeping abreast of what's new in science, and so on. However, a survey made by Professor Fletcher Watson of Harvard about a year ago strongly suggests that probably not more than twenty-five per cent of the high-school science teachers are members of *any* professional organization in their field. How well do the science teachers in your school compare with this national average?

The largest, most comprehensive, and most active organization for science teachers is National Science Teachers Association. It is unique in that it is a department of the National Education Association and is also an affiliate of the leading organization of the scientists of the United States, the American Association for the Advancement of Science. The action program of NSTA not only brings to all members and subscribers a wealth of practical information, materials, and ideas, but it also provides outstanding opportunities for professional participation. Last year, for example, close to 500 science teachers were involved through their services on committees, their participation in meetings and conferences, their contributions for publication in the Association's journal, *The Science Teacher*, through serving as officers and directors, and in other ways. We realize that NSTA cannot stand *in loco supervisoris* to all the nation's science teachers, but it does offer an open door to professional self-development opportunities of amazing scope and magnitude.

Lest the thought creep in that NSTA represents a bunch of science teachers going off the deep end in behalf of their own subject matter field, let us have a look at the policy statement adopted last summer at the Ann Arbor, Michigan, meeting of the NSTA Board of Directors. First, some highlights from the preamble: "... the National Science Teachers Association believes that science education in the public schools is entirely continuous with the remainder of public education, and that science education must therefore share responsibility for and participate in the achievement of the humanitarian and democratic aims which characterize best public education in the United States. It calls upon all science teachers to plan and to execute their contributions to public education in full co-operation with their colleagues in other educational fields... science teachers, like other special area teachers, contribute uniquely to the educational effort to achieve those humanitarian and democratic aims, and those special contributions, formulated in terms of specific aims for science education, constitute a valid set of guideposts for the design and conduct of present and future programs of action of the National Science Teachers Association."

And if you will bear with us a little longer, here are the ten statements which have been accepted as the basic educational aims of the Association:

1. The development of effective personal adjustment consistent with current scientific knowledge of the physical and biological environment, as a means toward achieving confidence and security in the world today.

2. The development, by each young person, of the habit of seeking the most reliable data to be used as a basis for discussion and in the determination of group and individual action.

3. The achievement, by all youth, of a clear understanding of the crucial dependence of the socio-economic life of the United States on the scientific and technological enterprise.

4. The location and support of those young people who show promise of growing into productivity in the scientific endeavor.

5. The establishment of adequate science education opportunity, in terms of the objectives above, for each child and youth at each grade level from one through twelve.

6. An adequate science education supervisory staff in each state department of education.

7. A professionally prepared and competent person in every science teaching position.

8. A strong and effective state science teachers association in every state.

9. A larger and more effective National Science Teachers Association.

10. Broader participation of state science education leaders in the formulation and execution of national association policies.

So far we have mentioned only the National Science Teachers Association. There are other organizations and services for science teachers which have much to offer. Local, state, and regional associations can, in many instances, render services and cope with problems which would be less well handled on a national scale; and, of course, the reverse is true. There are half a dozen or so periodicals in the fields of science and science education from which all schools and science teachers would derive helpful ideas and suggestions on methods and materials. To mention a few of these organizations and publications would perhaps be unfair to the many others which space limitations preclude mentioning. However, letters of inquiry sent to the writer by interested persons will receive full answers.

Adding up one word and another, what we seem to be striving for through our efforts with this issue of *THE BULLETIN* is the development of greater teamwork by high-school principals and their science teachers. We in the science classrooms need the stimulation, encouragement, and leadership of our principals. No one is in a more favorable position than the high-school principal when it comes to opportunities for on-the-job stimulation of professional improvement. No one is more zealous than the science teacher in wanting to see a sound and effective program of science instruction for all boys and girls. The opportunities for educational improvements in science are numerous, they are practical, they are inexpensive in terms of time and money. Through joint efforts in the better utilization of the programs, services, and publications of professional societies for science teachers, these teachers and their principals

can make tremendous headway along the path toward more functional, more effective education for all.

Thanks and appreciation are expressed on behalf of the Association to the Guiding Committee and to all the contributors whose co-operative efforts have resulted in this publication. May it be helpful to all who are concerned with orienting boys and girls to those basic understandings in science which are essential for successful living in this Scientific Age.

ROBERT H. CARLETON, *Executive Secretary*
NATIONAL SCIENCE TEACHERS ASSOCIATION

CHAPTER I

Science Education in American High Schools

A. The Administrator Looks at Science Education Objectives

HAROLD B. BROOKS
CLARENCE H. WOODRUFF

In this article, Dr. Brooks discusses the *what*, the *when*, the *where*, the *why*, and the *how* of science education in the secondary school. He discusses various objectives that the good school administrator considers in setting up functional courses of study in science or in evaluating them. He shows how science courses must be kept in line with the time. He states "that the principal who would build well in the field of science instruction must select his objectives both general and specific with care; he must be sure that they are sound in terms of educational philosophy, community understanding, and pupil needs and interests."

THE administrator's first concerns in any field of learning are those of a competent newspaper reporter—what, when, where, why, and how. In science, he, with others, determines *what* shall be taught on the bases of texts, courses of study, current scientific discoveries and reports, the needs and interests of both pupils and the communities in which they live, and the combined opinions of teachers and scientists.

When general science, physics, chemistry, biology, or physiology shall be taught is governed by such factors as pupil growth and development, custom as established over a period of years, viewpoints of teachers and parents, and available facilities.

Where science shall be taught is being answered in ever broader terms. It is taught in classroom and laboratory, in the field, in museums, and in the home. But it is taught daily outside of school influence, too; for this is predominantly an age of science and of scientific information available to young and old.

The *whys* of science teaching are almost endless. Most impressive reasons given are (1) the actual needs of individuals in their daily living, (2) the intense interests of pupils in all things scientific, (3) the opportunities opened up for scientific method in thinking, (4) the knowledge and understandings necessary

Harold B. Brooks is President of the National Association of Secondary-School Principals, Principal of Benjamin Franklin Junior High School, Long Beach, California. Clarence H. Woodruff is Supervisor of Junior High Schools, Long Beach, California.

for college entrance, and (5) the requirements of a well-rounded general education.

How science shall be taught is perhaps the most important consideration. Taught improperly, it can be a deadly recitation of memorized facts, with little or no meaning for the learner. Taught properly, it is a flexible, functional inquiry and exploration into a fascinating universe of facts, ideas, speculations, discoveries, and conclusions. Science well learned is a basis for living and a philosophy of life, as well as a body of knowledge. *How* taught and *how well* taught, in the final analysis, will always depend upon the teacher's depth of knowledge, his enthusiasm, his technical skills, his love of youth, as well as his devotion to his subject, his breadth of view, and his experience.

The principal, then, is concerned with all that pertains to any science course in his school. He wants a modern course of study, competent teachers, ample materials of instruction, good classrooms and laboratories, and an understanding on the part of his community of the necessity for science teaching in today's civilization.

The principal's goals, in short, are the general objectives that the best science teachers everywhere have set for themselves and their pupils. These objectives are widely known and accepted: (1) to develop interests, (2) to meet immediate and future needs, (3) to develop skills and habits, (4) to develop knowledge and understandings, and (5) to develop attitudes and appreciations in the field of science.

When interests are properly met, these things happen—immediate curiosities are satisfied, new fields for exploration are opened, and new vocational and avocational possibilities are revealed to the pupil. The development of skills and habits includes further growth in the power of the individual to observe carefully and accurately, to manipulate the tools of science with precision, and to put order and neatness into all of his work. Knowledge and understandings are developed from the materials of environment, from the great forces of nature, from the varied phenomena of the physical and biological world. Worthy attitudes and appreciations grow with scientific inquiry and method. A respect for the extent and importance of science in the life of modern man and a reverence for the beauty and orderliness of nature are all but inevitable as true knowledge and understandings are achieved.

The broad general objectives of science are of course made operative as they are broken down into specific objectives, unit by unit, problem by problem. For example, the specific objectives in the study of air in junior high-school general science might well include such items as are listed below under the categories of understandings, skills, and appreciation of the dependence of life on the chemical and physical behavior of air.

Specific objectives in understandings might be (1) to develop a knowledge of the physical properties and composition of air, (2) to understand the relationship of air to oxidation, maintenance of life, weather and climate, food pro-

duction, and others as time would permit, and (3) to learn how man makes use of air as with windmills, compressed air, air-borne vehicles, crop-dusting, and the like.

Specific objectives in skills for a unit on air are all but endless. Examples of skills which suffice to point out the variety available for selection are barometer and anemometer readings, prevention of rust and decay by oxidation, and the practical use of pumps and siphons. Specific objectives in appreciations of the part air plays in the total scheme of things grow ever more challenging. Today, the pupil may well be called upon to appreciate the problems of air navigation and exploration, air pollution by factory gases, and, even more broadly, man's never ceasing dependence upon air.

The determination of general objectives, and the specific objectives which will further pin-point the outcomes that both teacher and pupils should seek, is of course but the first big step in the process of science instruction. But, if that step is not thoroughly and carefully taken, all attempts at teaching will falter and eventually fail.

In no subject field in secondary education are changes and additions to knowledge and skills growing as they are in science. All persons concerned with the teaching of science must be constantly ready to change and add to the objectives of any science course offered in the high schools. Not so long ago, there was little understanding of the structure of the atom by the best of college physics or chemistry teachers. Today, every informed citizen has urgent need to understand the fundamental facts of atom structure and of nuclear fission. Every school where science is taught must add the objectives that relate to this and other new discoveries of importance if science is to meet present and future needs and interests, develop essential skills and habits, and keep knowledge and understandings in line with the times.

In addition, the principal, as he views the general objectives of science, is anxious that they merge with the general objectives of the social sciences, and that their implementation take place in close harmony. Science teachers and social studies teachers have an obligation, as never before, to join their efforts to educate the youth of America, in ways that will lead them intelligently and ethically, to find answers to the *whats* and the *hows* and the *whys* that beset man at this stage of his evolution.

Scientists and science teachers, if modern civilization is to survive, must increasingly recognize the social consequences of their acts and the responsibilities that are theirs in giving mankind vast new stores of scientific knowledge, which can be well or ill used. Social scientists and teachers have equally important obligations. They must keep up-to-date in their scientific knowledge and scientific methods of thinking, if they are to lead mankind to better ways of living. The principal in his school has the immediate responsibility of uniting his science and social science teachers in a co-operative, integrative approach to their work as teachers.

The writers venture to predict that the general objectives of science teaching and those of social studies teaching will rapidly be merged in the high schools of America. Such action may well be the first step to the solution of many of society's most perplexing problems.

When objectives have been carefully chosen, the first step has been taken in the process of teaching science. The next steps will be faltering ones, if the contents of courses and classroom procedures are not equally well considered, and, when chosen, put functionally to work.

Courses built on textbooks alone will always be behind the times, for books cannot keep up with the swift march of science. Courses, it is true, should take advantage of ideas, facts, presentations of problems, illustrations and diagrams, laboratory guides, and all other offerings which abound in good texts. But these courses should also include the wealth of materials which pour forth day by day in the forms of newspaper reports, magazine articles, pamphlets, moving picture presentations, radio and television programs, and, in some cases, the technical papers presented by the science research workers.

Courses, at the secondary-school level, however, should always be presented with a minimum of technical nomenclature. The phraseology of the technician can always be translated into the language of the layman. It is the duty of the writer of high-school courses to see that the translation is made into clear, forceful English that is understandable to all concerned. Clear cut ideas or knowledge can be given clear expression. Ideas or knowledges that possess impact can always be forcefully presented.

Courses that include on-going discoveries and advances have the advantage of being up to date. They have the equally important characteristic of flexibility. Stale, stereotyped courses, outmoded and boring, are impossible in those schools that insist upon the importance of including the best of the new along with the splendid array of the tried and true, long known to man.

Courses, that are carefully keyed to the interests of modern youth are better, naturally, than are those courses written strictly from the adult point of view. For example, a course in biology that permits each person to pursue a particular interest or hobby, as well as the general items presented to the entire group, will be more enthusiastically accepted by pupils than other less imaginative courses. Physics courses that include studies of everyday scientific problems encountered by the young motorist or the budding photographer will be more readily acceptable to youth, and will develop better scientific knowledges and attitudes than the courses that ignore this obvious approach to learning.

Even though objectives and courses are excellent, they are as nothing if teaching procedures are archaic. The chemistry teacher who insists that pupils read materials that are beyond their comprehension defeats himself as well as the members of his classes. The biology teacher who closes his ears to the problems of youth engaged in raising racing pigeons, rabbit breeding, market gardening, or what not has missed golden opportunities for the best kinds of teaching.

The general science teacher who fails to capitalize upon the butterfly collection of Mary Smith or the telescope Jimmy Jones is building is remiss as a classroom guide and leader for young people.

Classroom procedures in terms of methods and techniques will always depend largely upon the philosophy of the teacher, his background socially, as well as professionally, his understandings of the growth and development of pupils, his personality, and his experience. No set system of methods and techniques will ever suffice for all teachers or even for any single teacher from year to year. For methods and techniques are tied intimately to the interrelationships of teacher and pupils, which change not only from year to year, but also from day to day.

The best methods are the ones that prove themselves in any given situation. The teacher who wants to use the best with his class will study all methods and experiments with them. He will adopt the methods of others only as he can adapt them to his own classroom. He will not "be the first by whom the new is tried, nor yet the last to lay the old aside." He will follow the middle way followed by those pioneers in thinking, the ancient Greeks, who counseled moderation in all things.

In summary may it be said that the principal who would build well in the field of science instruction must select his objectives, both general and specific, with care. He must be sure that they are sound in terms of educational philosophy, community understandings, and pupil needs and interests. He must continuously survey classroom practices and strive through in-service training to keep his teachers at high levels of achievement.

He must be alert to the necessity for keeping courses in line with the times. He must see that his science curriculum is constantly revised. Science knowledge grows with startling rapidity. Pupils very often, these days, make an old, out-dated course "look silly." Science marches on, and so do the principal and his school, if he and his teachers are aware of their responsibilities, their resources, and above all their opportunities.

Science teaching challenges the best in the principal and his teachers. The challenge, met with courage, enthusiasm, and insight, will make all of the tomorrows in America even better than yesterday and today.

B. A High School Teacher Looks at Science Education Objectives

CHARLOTTE GRANT

Miss Charlotte Grant lists and discusses ten objectives of science education. She then discusses the various implications of these objectives. She believes that "with administrative understanding and co-operation, the science teacher will go far in achieving the goals of science education."

BELOW are listed some of the objectives of science education. There are others which are broader, and still others which are more specific. Each of these may be broken down into sub-objectives; each presupposes a definite goal toward which the science teacher is striving.

1. To develop skills in the classroom and laboratory
2. To meet the needs and interests of pupils
3. To help pupils to acquire knowledge with an understanding of relationships and application to everyday living
4. To build a scientific vocabulary
5. To develop attitudes and appreciations
6. To help pupils explore new fields of interest
7. To discover aptitudes and abilities in pupils, and to direct these into useful channels
8. To develop sustained critical thinking and evaluation
9. To teach an understanding of people and ways of working together
10. To help pupils formulate a philosophy of life with a wholesome and workable set of values

In order to follow through to definite goals, the science teacher must possess certain attributes and be surrounded by a favorable set of working conditions. Naturally he must be well-trained in science and know the techniques of carrying out experiments or putting on a demonstration. But in addition, he must possess true initiative and interest in young people, an insatiable desire to find out why things work as they do, a long-enduring patience, emotional stability, sense of humor, an ability to motivate and guide his pupils, and a deep pride in accomplishment.

The administrator of a school will know when he has such a teacher on his staff for the pupils will bear witness to the fact. Their interest, conversation, achievement, and planning ahead will be indicative of the type of course offered and the attributes of the person offering it. Parents, too, will know and speak of the reactions of their sons and daughters, for there are lengthy family conferences around the dinner table on school experiences.

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A school administrator can always be happy that he selected a staff portraying such fine attributes, but he also recognizes that, in order for his science staff to carry forward their objectives, he must give them every co-operation and support and provide favorable working conditions and satisfactory equipment.

The science teacher must not be overloaded, for extra time is needed to plan and set up experiments and demonstrations. Perhaps a willing and capable pupil can act as laboratory and classroom aid. Many science teachers are engaged in extracurricular and extramural activities because they are fitted to do so and can make additional educational contributions in these areas. This, then, is a second reason for not over-loading the classroom and laboratory schedules of such teachers.

In some small schools, a teacher must teach four or five different subjects in one school day. This situation may become very frustrating to a good teacher and cause a lack of interest to develop or a minimum of effort to be given to each subject. Such situations truly need the understanding, scrutiny, and support of school administrators, with an alleviation of such a program if possible.

Equipment which is up-to-date in working condition and ample in quantity should be the ultimate goal in all schools. Only with such equipment can a staff feel that progress is being achieved and that the well-being and happiness of the school population is being considered. Such equipment includes not only ample and satisfactory materials for science classrooms and laboratory work, but also comfortable seats and desks, adequate lighting, and proper heating and ventilation. Color schemes which are light, nicely blended, and pleasing to the eye in school rooms may be important factors in maintaining good mental health of pupils and teachers.

Classes of thirty or fewer are a distinct aid in enabling science teachers to carry through on the objectives previously listed. The smaller the class, the better the teacher will know his pupils and the more individual attention he will be able to give. In this manner, he will have a better opportunity of meeting varied needs and of exploring interests and aptitudes. Of course his pupils must learn to work together, that is one of the prime objectives, but to seek out and guide able individuals is also a vastly important objective. Within the teacher's reach may be a future scientist, inventor, doctor, or dietitian. What a challenge to the science teacher exists in each new class, and in each new pupil! He recognizes that his job is a privilege, for he is not only opening up new avenues of knowledge, but also molding and shaping future careers. He will follow many of his pupils to determine whether and where he or she went to college, and what kinds of vocations were selected after graduation. With administrative understanding and co-operation, the science teacher will go far in achieving the goals of science education.

C. The Role of Science Education in a Democracy

GERALD WENDT

In this article, Dr. Wendt identifies the four major aspects of science as research, knowledge, applications, and the social force which it exerts. He discusses each of these in terms of the needs of society and the individual, and in terms of the responsibility of the secondary school. He pleads against the common error of emphasizing one or some of these aspects at the expense of the others. In closing, he identifies the goal of secondary-school science education as the preparation of young people for life in the last quarter of the twentieth century and the first years of the next. He contends that, since no teacher knows the nature of these years to come, the education of young people must prepare them to cope with "constant and inexorable change."

SCIENCE is many things. It is too wide a concept to be discussed without first a look at its four major aspects. They are:

1. *research*: the creative use of our powers of inquiry, the expert method of exploring the unknown and of solving the problems posed by nature and by life;
2. *knowledge*: the vast fund of facts, principles, natural laws, and generalizations that are the product of research and have been recorded in print and in picture;
3. *applications* of that knowledge in the production of things and of power, in the improvement of our environment and the enrichment of life through the techniques of agriculture, medicine, engineering, and industry;
4. *the social force* that springs from these applications and, by transforming time, space, matter, and life itself, inevitably transforms man and society, history and cultures, philosophy and even religion.

Each of these four is a world in itself. No man can master them all. Because it is seldom recognized that science has so many meanings, discussions of science are too often the words of blind men describing their part of the elephant. Even the scientists themselves, or perhaps especially the scientists, are too close to their limb to speak wisely of the whole. But any leader of thought, and especially any teacher or school administrator, must be aware of all four aspects and should specify whereof he speaks.

In a democracy and in a democratic school system this is peculiarly important because education for citizenship requires sufficient awareness of the first three to permit evaluation of the fourth, the social power of science, while education for earning a living must open for each youngster the door to his suitable speciality in scholarly knowledge or in its useful applications; and the genius for research must be found and developed wherever, by strange accident of birth, it appears. It is a fourfold challenge.

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There is now general agreement that in our democratic American educational system the secondary school is not the place to train specialists in chemistry, biology, medicine, or agriculture, though special aptitudes should be discovered and encouraged. The time for specialized training in any one science or application comes later. But it is not so generally understood that undue emphasis on any one of the four major aspects of science, as listed above, is also premature. Occasionally it is the applications that are stressed, such as agriculture or engineering, usually because of the local environment and the opportunities there for quick employment. More often knowledge is imparted for its own sake, as if science were only knowledge and pure knowledge were power. Neither is true today, nor is it the role of the science teacher merely to impart information. If he does only that, no matter how well, he ignores those aspects of science which for the ordinary citizen are far more precious than the knowledge of facts; namely, the research thinking that produces the facts and the social thinking that gives facts their meaning. It is this broadening of objectives that characterizes modern science teaching, as many of the subsequent articles in this publication will show.

Research thinking, under the guise of the "scientific method," has indeed become a popular objective. It is the primary justification for experiments and laboratory teaching. Observation, reasonable guesses, tests, evidence, and conclusions are a logical, convincing sequence and the origin of all science. But they are more than scientific; they are the basis of all reliable knowledge. They are used by explorers, detectives, financiers—and infants. Every baby is a born researcher and quite naturally uses the experimental method of research—not, surely, the scientific method—to explore and master his small universe until the time when adults, at home or in school, save him the effort by telling him the answers and explanations. Thus, they inevitably introduce education by authority, substitute memory for investigation, and can convey misinformation and prejudice as easily as the truth when the inborn research instinct of the child is quelled. It is the great role of science in the primary grades to keep curiosity and the adventurous research spirit alive, for the hope of mankind lies not in authoritative answers but in the power of research eventually to solve all problems in whatever field.

Science education in the secondary school can enliven and focus the native research mind both by revealing the great vista of desirable knowledge and by encouraging the pupil to find the answers for himself, if only by library research. If this be done by inspired teachers, by voluntary science clubs, or by such devices as science fairs or a "talent search," the gifted pupils will emerge, ready for selection into careers of scientific research that will keep this country in the forefront of progress. This is one important goal of secondary education. But equally important is the larger result that other pupils too, non-scientists, learn to respect the habit of research, to keep open minds, and to face the problems of life optimistically with the conviction that problems are meant to be solved and

that research thinking can solve them. To welcome a problem instead of fearing it is half the battle of life.

And at the other end of the list of the aspects of science, so often ignored, is its impact on society. This is its liveliest aspect. Everyone knows that we live very differently from the ways of our ancestors, or even of our parents, and it takes but little thought to realize that it is the advance and use of science that has caused the change. Yet somehow it is not generally appreciated that the progress of science always brings social changes. Many an oldster is all for progress—so long as nothing is changed. But in a country that spends more than two billion dollars a year on scientific research, social change is as inevitable as growth and evolution, and much swifter. The American citizen of tomorrow must anticipate change, more change in a decade than our fathers saw in a century, and he must know that the force that brings social change is science. It is not enough for us now to study social changes effected by the results of past researches—by airplanes, television, or antibiotics, for instance. A citizenship properly educated in science would study now the inevitable social changes that will result from present researches in space travel, in photosynthesis, or in the control of the fundamental life processes. If foreseen, those changes can be guided to do man good instead of harm.

Most of the youngsters now in secondary school will live well into the twenty-first century, for their life expectancy at seventeen is some fifty-five additional years. Can we educate them for life in the next century? No teacher knows enough for that. But we can educate them for constant and inexorable change. And we can, with good science teaching, let them see the source of those changes in the researches that are now in progress in the laboratories. Only with a good science education *now* will the United States Congress of the year 2000 be able to cope with its responsibilities. Indeed, long before that year, society will have to cope with automatic factories, space travel, cheap and unlimited industrial energy from the atom and from sunshine, overproduction of everything including food, and four billion people on earth, all with time on their hands. Will the Congress of 1980 have had the necessary education in science? Or is it already too late?

Such are the questions that trouble an experienced observer who has learned long ago that teaching science is a far larger responsibility than is generally appreciated. The role of science education in a democracy today is to prepare all present pupils for a mature life in the last quarter of this century and the first years of the next when the conditions of life will be totally different from our own and when an understanding of all four aspects of science will be indispensable for the successful conduct of each business and profession, for the duties of citizenship, and for the enjoyment of literature, leisure, and current thought.

D. Occurrences of Science Courses in American High Schools

PHILIP G. JOHNSON

In this article, Dr. Johnson draws upon three recent nation-wide statistical studies to summarize the *status quo* of today's high-school science education. The first part of the analysis includes (a) occurrence of science courses expressed in enrollments, (b) occurrence of science courses expressed in number of courses offered, and (c) science requirements for graduation. The latter portion concerns the occurrence of science courses as enrollments in them have varied throughout the recent half-century. An excellent summary appears at the end of the article.

DATA concerning the occurrences of science courses as reported in this article were obtained from three principal sources. These were:

a. The 1947-48 report on the *Teaching of Science in Public High Schools*.¹ Data for this study were based on an inquiry sent to an approximate three per cent stratified random sample of public high schools, to which 97.1 per cent of the schools in the sample responded.

b. The 1948-49 survey of *Offerings and Enrollments in High-School Subjects*.² Inquiry forms for this survey were sent to all public high schools with enrollments of 500 or more (of these 91.8 per cent responded) and to one half of all high schools with less than 500 pupils (of these 75.1 per cent responded). Statistical corrections were made for schools not included and for schools that did not supply data.

c. The 1949-50 *Study of the Teaching of General Biology in the Public High Schools of the United States*.³ This study was based on a data form sent to an approximate five per cent selected sample of public high schools of which 73.3 per cent provided usable data. The sample included more large high schools than a representative sample of high schools would have included. Usable data were obtained from 3.5 per cent of the public high schools of the United States.

While none of the sources provides a full view of the offerings, yet the composite of these data offers a reasonably complete view of the occurrence of science courses in the public high schools of the United States.

OCCURRENCE OF SCIENCE COURSES

Among all the usual science courses, general science at the eighth-grade level appears to be the most common science offering in high schools that include an eighth grade. Biology is the most common science course in the four-year high schools. This is followed by general science, chemistry, and physics. A

¹ Philip G. Johnson. *The Teaching of Science in Public High Schools*, Bulletin 1950, No. 9. Bulletin available from The Superintendent of Documents, Washington 25, D. C. 20 cents.

² Mabel C. Rice, J. Dan Hull, and Grace S. Wright. *Offerings and Enrollments in High School Subjects, Biennial Survey of Education in the United States—1948-1950*. Bulletin available from The Superintendent of Documents, Washington 25, D. C. 30 cents.

³ W. Edgar Martin. *The Teaching of General Biology in the Public High Schools of the United States*. Bulletin 1952, No. 9. Available from The Superintendent of Documents, Washington 25, D. C. 20 cents.

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large number of other science courses occur in our public high schools especially in the larger high schools.

Five science courses were reported from every state in 1948-49.⁴ Others were reported from fewer states. The various types of science courses, the number of states (including the District of Columbia) in which the courses were offered, and the number of pupils enrolled in 1948-49 are given in Table I.

TABLE I. THE OCCURRENCE OF SCIENCE COURSES BY STATES AND THE ENROLLMENT IN THESE COURSES IN 1948-49

<i>Types of Science Courses</i>	<i>Number of States in Which Course Was Offered</i>	<i>Number of Pupils Enrolled</i>
General Science, eighth grade	49	612,135
General Science, ninth grade	49	1,073,934
Biology	49	989,756
Chemistry	49	406,662
Physics	49	278,834
General Science, seventh grade	48	473,901
Aeronautics	47	14,959
Physiology	42	53,592
Advanced General Science	42	48,046
Earth Science	38	20,575
Radio, including electronics	27	3,248
Fundamentals of Electricity	23	2,417
Related Science	22	7,332
Physical Science	21	7,006
Advanced Biology	20	3,576
Advanced Chemistry	18	1,857
Botany	17	7,670
Conservation	16	3,546
Zoology	15	5,051
Applied Physics	14	4,399
Applied Chemistry	12	3,882
Fundamentals of Machines	11	1,533
Other types of science courses	Fewer than 10	7,133

According to the stratified random sampling study of 1947-1948,⁵ the occurrence of selected science courses in public high schools during a particular term was as shown in Table II.

TABLE II. PER CENT OF HIGH SCHOOLS (HAVING GRADE WHERE COURSE WAS COMMONLY TAUGHT) AND OFFERING SELECTED SCIENCE COURSES DURING THE FIRST TERM IN 1947-48

<i>Science Course</i>	<i>Per cent of Schools Offering Course</i>
Eighth-grade General Science	96.3*
Biology	85.2**
Ninth-grade General Science	77.4*
Seventh-grade General Science	71.6*
Chemistry	49.4**
Physics	47.8**

* based on high schools having seventh, eighth, and ninth grades, respectively.

** based on high schools having tenth, eleventh, and twelfth grades.

⁴ *Op. cit.* Rice, Hull, and Wright.

⁵ *Op. cit.* Johnson.

The study of the teaching of biology,⁶ using a somewhat different sample, reported that 95.1 per cent of the schools responding to the questionnaire offered general biology or a course equivalent to it in 1949-50. Of all these schools in the sample about ten per cent offered the course in alternate years or once in each three years. A total of forty biological science courses in addition to general biology were offered in the 786 schools. The general nature and the per cent of schools offering these additional courses are shown in Table III.

TABLE III. BIOLOGICAL SCIENCE COURSES OFFERED IN PUBLIC HIGH SCHOOLS IN 1949-50

<i>Courses in Biological Science</i>	<i>Per cent of Schools in Sample Offering the Courses</i>
Health	47.4
Agriculture	37.1
Hygiene	17.3
Physiology	9.8
Advanced Biology	7.6
Conservation	6.2
Nature Study	4.6
Botany	3.6
Zoology	2.8
All other biological science courses	10.8

Among these schools, the larger schools often offered as additional biology courses the advanced biology types of courses, while the smaller schools frequently offered conservation as an additional course. The health course offered either in the science department or in the physical education department varied from a one-semester course to an offering in each semester of the last four years of high school.

SCIENCE REQUIRED FOR GRADUATION

The amount of science required for graduation provides some information concerning the extent of science in the schools. The requirements as reported for the 1949-50 study⁷ revealed that somewhat more than one half the schools required two semesters of biology. The entire science requirement is shown in Table IV.

TABLE IV. AMOUNT OF SCIENCE REQUIRED FOR GRADUATION IN VARIOUS CURRICULA OF PUBLIC HIGH SCHOOLS IN 1949-50

<i>Semesters of Science Required for Graduation</i>	<i>Per cent of Schools Requiring Specified Amounts of Science</i>		
	<i>College Preparatory Curriculum</i>	<i>Vocational Curricula</i>	<i>General Education Curriculum</i>
1 semester	9.1	12.0	13.1
2 semesters	42.0	53.1	56.7
3 semesters	4.2	3.2	2.0
4 semesters	31.1	22.8	22.0
5 semesters	.3	.6	.4
6 semesters	10.1	5.1	2.5
More than 6 semesters	3.2	3.2	3.3
	100%	100%	100%

⁶ *Op. cit.* Martin.

⁷ *Ibid.*

THE GENERAL TREND OF SCIENCE ENROLLMENTS

It is difficult to reveal general trends in science enrollments so as to present a picture that takes into account the variables inherent in reports received from the schools. While the U. S. Office of Education has from time to time collected statistics on enrollments and the great majority of schools have sent in carefully prepared reports, not all the schools have done so. In this regard, only public high schools have been asked to provide data on subject enrollments. Furthermore, while enrollments in the various subjects have been reported, it has been impossible to secure information concerning subject enrollments when courses are offered in alternate years or once in three years. The great variety of names used for science courses have made it difficult to relate courses to each other and, thus, arrive at the composite enrollments in a few basic subject areas. Finally, statistics have been collected at irregular intervals and the fluctuations between these periods may conceivably be great, yet the change must be shown as a straight line between known statistics. While each graph shows enrollments in science courses in relation to the particular year when the course is commonly offered, it should be understood that enrollment in the science course often included pupils from other years of high school. These circumstances and other variables should be kept in mind when graphs of enrollments A, B, C, and D on the following pages are studied.

CHANGES IN SCIENCE ENROLLMENTS BY PER CENT

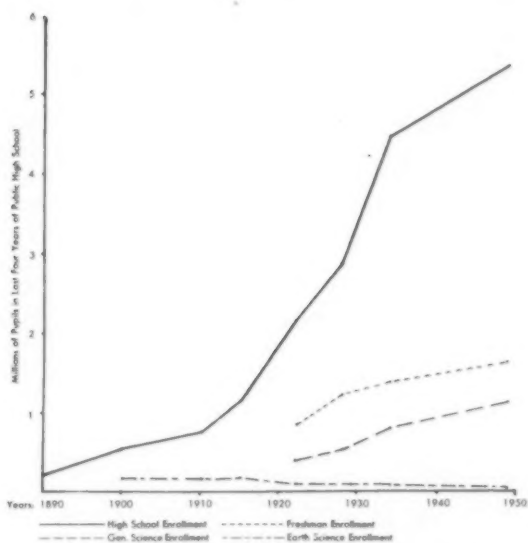
The comprehensive survey of enrollment for 1948-1949⁸ provided a basis for comparisons with earlier comprehensive surveys. In treating the data from such studies, for Table V, attempts were made to group subjects so as to provide comparable courses. The per cent in each case refers to the number of pupils in the last four years of public high schools who were enrolled in the science course at the time the survey was made.

TABLE V. ENROLLMENTS IN SCIENCE COURSES BY PER CENT OF PUPILS IN THE LAST FOUR YEARS OF PUBLIC HIGH SCHOOL

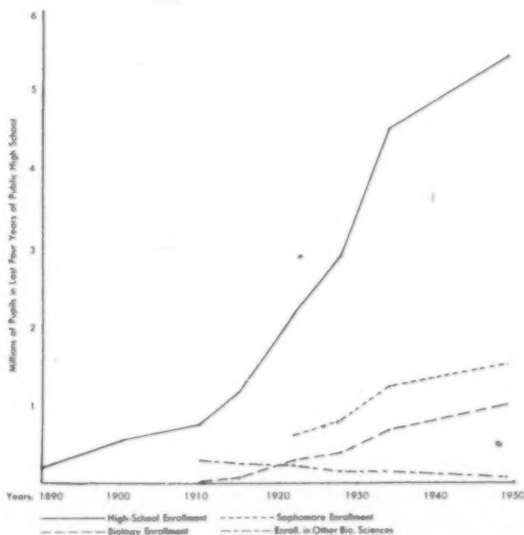
<i>Science Subjects</i>	<i>Per cent of Pupils in Last Four Years of High School</i>					
	1910	1915	1922	1928	1933-34	1948-49
General Science	18.3	17.5	17.8	20.8
Biology	1.1	6.9	8.8	13.6	14.6	18.4
Botany	15.8	9.1	3.8	1.6	.9	.1
Physiology	15.3	9.5	5.1	2.7	1.8	1.0
Zoology	6.9	3.2	1.5	.8	.6	.1
Earth Science	21.0	15.3	4.5	2.8	1.7	.4
Chemistry	6.9	7.4	7.4	7.1	7.6	7.6
Physics	14.6	14.2	8.9	6.8	6.3	5.4

This table shows that botany, physiology, zoology, and earth science have each decreased consistently in per cent of enrollment from 1910 to 1949. The

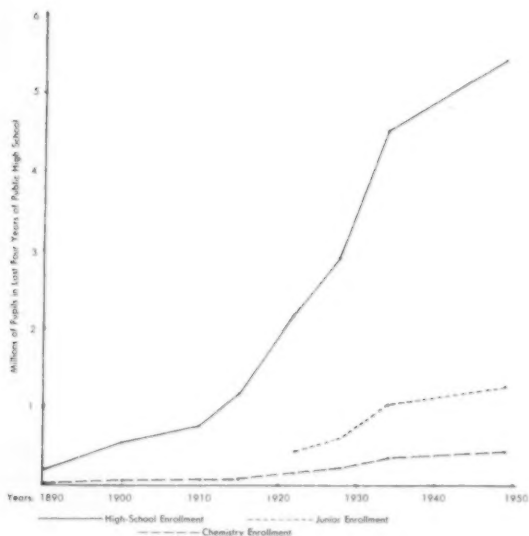
⁸ *Op. cit.* Rice, Hull, and Wright.



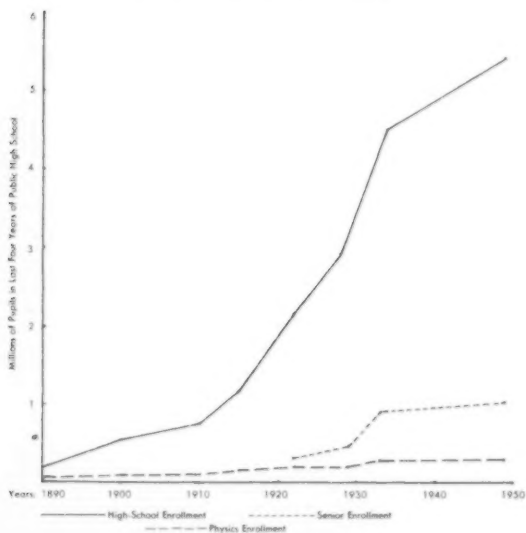
Graph A. Enrollment in Public High Schools, in the Freshman Class, in General Science and in the Earth Sciences.



Graph B. Enrollment in Public High School, in the Sophomore Class, in Biology, and in other Biological Sciences.



Graph C. Enrollment in Public High Schools, in the Junior Class, and in Chemistry.



Graph D. Enrollment in Public High Schools, in the Senior Class, and in Physics.

actual enrollment in these subjects has also decreased and reached a new low in 1948-49. While enrollment in physics has declined in per cent, it has increased from period to period in the actual enrollment. The increase between the 1933-34 and the 1948-49 period was, however, only 8,577 pupils. General science and biology have increased greatly in actual enrollment so as to double the number of pupils enrolling in these subjects in the course of twenty years. Some new types of science courses that have come into the high-school program and the enrollments in them in 1948-49 were: aeronautics (14,959), advanced general science (48,046), advanced biology (3,576), applied chemistry (3,882), advanced chemistry (1,857), applied physics (4,399), advanced physics (1,042), physical science (7,006), radio (3,248), applied biology (2,598), conservation (3,546), and laboratory techniques (1,239). Some other science courses introduced during the war still remain. These include fundamentals of machines and fundamentals of electricity. Another science related course which is sometimes taught in the science department and sometimes in the physical education department is a course called Health. This course enrolled 1,816,569 pupils in 1948-49 or 26.3 per cent of the pupils in their last four years of high school. Many science related courses are taught in the industrial arts program and in the vocational education program. Among those rather closely related to science are photography with 7,469 pupils in the industrial arts program and 1,177 in the vocational program. Others include electrical work, aviation, home mechanics, plastics, and the like. Courses in agriculture enrolled 373,395 pupils in 1948-49. This represented 5.4 per cent of the pupils in their last four years of high school.

SUMMARY

An analysis of the occurrence of science courses in public high schools reveals that general science, biology, chemistry, and physics are offered in all of the states and the District of Columbia. General science and biology appear to occur in almost all high schools while chemistry and physics are offered in the larger high schools but often fail to occur in the smaller high schools.

While the number of pupils enrolled in the sciences has increased consistently, the large increases have occurred in general science and in biology. There have been consistent decreases in botany, physiology, zoology, and earth science. While chemistry and physics have shown consistent gains in the actual numbers of pupils enrolled, chemistry has maintained its percentage of the pupils enrolled in high school but physics has lost consistently in its percentage of the pupils.

Two semesters of science, often biology, are the most common requirement for graduation from high school; but many schools require four or more semesters of science. Many new science courses have appeared especially in the larger high schools. Science instruction has also come to be a part of physical education, industrial arts, and vocational education.

The changes in science enrollments, the introduction of new high-school science courses, the increasing expansion of science instruction as a part of elementary education, the development of science instruction as a part of general education at junior college levels, and the increasing concern about shortages of scientific, engineering, and technological personnel make it appropriate for educational leaders to restudy their science courses and the facilities provided for science instruction.

E. Science Education in a Large School System

ARTHUR O. BAKER

In this article, Dr. Baker discusses some of the outstanding problems and possibilities associated with science instruction in a typical large city school system. As a background, he summarizes a basic philosophy of science education and outlines current curriculum practices for the entire public school sequence of kindergarten through the twelfth grade. He concludes by outlining broader horizons for science instruction and by spelling out the implications of this enriched program in terms of the need for better prepared teachers of science.

A PHILOSOPHY FOR SCIENCE EDUCATION TODAY

VARIOUS departments, divisions, and services of instruction make up what, in a large city school system, is called the "School." Commonly, the departments exist under such headings as: art, music, physical training, social studies, language, mathematics, home economics, industrial arts, and science. In addition to these typical departments, there are other school services and activities organized around such divisions as: major work classes, school lunch rooms, health services, special schools and special classes, educational research, child accounting, psychological service, and many others. Each of these departments, divisions, and organized services is concerned with serving and training boys and girls. In serving and training boys and girls, each department, division, or service operates a program built in terms of meeting what are conceived to be the best interests of boys and girls. When properly administered, certainly each department, division, or service makes tremendous contributions to the accepted aim of education—well prepared boys and girls. Within the scope of this treatment, an analysis will be made of the contribution which instruction in science should make to the total growth and development of boys and girls.

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Science for Living Today

Boys and girls must be educated through science, in part, to live more effectively. But to live effectively, they need to be prepared to cope with those problems of daily living which arise in their environment. This environment, having both a biological and physical component, has become increasingly complicated as a result of scientific research and development. Certainly boys and girls must develop basic understandings about this environment. Obviously, they will need to learn much about plants and animals, as well as many things about the earth, sky, weather, atoms, electrons, and other physical factors and phenomena.

The barrage of information which could be thrust upon pupils in science classes could be very detailed and meaningless. Hence, it must be made certain that pupils are not trained haphazardly so as to wind up with a smattering of science and an incoherent mass of scientific terms. A program in science must be organized in terms of basic fundamental concepts. These concepts must be so classified as to be meaningful. They must then be sorted into grade levels, partly, according to difficulty. They must be sorted, also, in terms of their relationship to the needs, interests, and capacities of pupils at the respective grade levels.

It would appear, then, that for a science program to be effective it must be coherent, meaningful, and practical. Pupils in this program should be expected to learn to distinguish truth from propaganda. In following the program from one grade level to another, they should become increasingly skilled in applying scientific method and procedure to daily living. They should also learn to relate health science to the care of the body and the maintenance of physical fitness. Pupils should develop, too, a cultural knowledge of science so as to be able to make a more worth-while use of leisure time.

Finally, through the study of science, pupils should be expected to grasp something of the relationship of this subject to the work-a-day world including relationships to jobs that are technical, skilled, and unskilled. Certainly pupils should learn about the problems of the community, the state, and the nation that are scientific in nature, and to sense the relationship of science to problems that are of international concern.

THE CURRICULUM IN SCIENCE

It is recognized that science is not offered at each of the twelve or thirteen grade levels in all large school systems. However, many of these systems do offer science in some form at each of the respective grade levels. For example, broad or integrated units of instruction may include science experiences in the kindergarten and primary grades. In the upper elementary grades, separate courses of study for grades four, five, and six are found in many school systems. However, science may be taught only two or three times per week in many of these situations. There are probably very few of the large school systems in which science is taught five times per week throughout grades four, five, and six.

In like manner science may be offered two or three times per week at the junior high-school level, particularly, in the seventh and eighth grades. More often, it may be offered five times per week at the ninth-grade level. Frequently, one or more years of instruction in science are required at the junior high-school level. The same situation often obtains at the senior high-school level.

Many science educators feel that units or courses of instruction should be offered or required at all grade levels because science is so closely related to the problems of everyday living. Some science educators, too, are inclined to feel that science is not receiving an adequate amount of time in the already overcrowded curriculum. There is a definite need for a further evaluation of the problem of instruction in science. This evaluation should lead to measures which will insure that boys and girls will have an opportunity to learn those basic concepts in science which are pertinent to each of the respective grade levels.

Science in Kindergarten-Primary Grades

At a very early age children become curious about the world in which they live. When they first enter school at the kindergarten level they are beginning to ask many questions about this world. In finding answers to these questions, children begin to think about the things of science.

Kindergarten children are not too young to begin to use the scientific method. Normal curiosities of children can be directed toward the development of scientific attitudes, and, guided by the teacher, pupils can learn to gather evidence, evaluate it, and draw conclusions. The science concepts which can be developed at this level must be simple and well within the experience of children. These simple concepts form the foundation upon which the later levels in science teaching can be built.

Science in Upper Elementary Grades

In the upper elementary grades, as children become acquainted further with living things, both plants and animals, they begin to appreciate the interdependence of plants and animals and also their own dependence on both. In addition, they become aware of the dependence of plants and animals upon the soil. Early in the upper elementary science program pupils sense the significance of the problem of conserving natural resources.

Children soon develop an awareness of the physical world and the importance of force or power and machines in daily living. They soon become aware of the forces of wind, water, and steam and their importance in industry. Experiments help them to understand how man harnesses these forces to work for him. Simple understanding of a machine invariably leads to the question, "How does it work?" Hence, children can begin to develop appreciation of the experimental method of science.

Briefly, upper elementary science can introduce children further to their environment. It helps them find answers to many questions about it. Pupils should leave elementary science with a realization that there is still much to find out as they continue to junior high school. Some may even feel that perhaps they may be the ones to extend scientific knowledge to new frontiers.

Science in the Junior High School

At the junior high-school level, pupils can be encouraged to explore science hobbies and interests. These hobbies and interests can be given further encouragement through science clubs and science museum activities. In nearly all schools the science room can be teeming with insect, leaf, or rock collections; mounted specimens of birds and animals; and small student-made electrical gadgets or machines.

Attention can be given to garden science with gardening units occurring in the seventh, eighth, and ninth grades. In like manner, health science, nature study, and physical science units can be introduced into the courses of study for grades seven, eight, and nine.

Science in the Senior High School

At the senior high-school level, science content is generally organized into specific subjects such as biology, chemistry, physical science, and physics. Hence, more detailed and specific science concepts can be developed. Basic fundamentals can be used to give pupils a broader understanding for living in and coping with the environment. Much of the health science related to teenage problems can be taught through biology. However, in many school systems separate and additional health courses have been introduced.

For those pupils who do not care to take the high-school program in physics or chemistry or for those pupils who might find physics and chemistry too difficult, a course in physical science is sometimes offered. It is taken commonly by eleventh- or twelfth-grade pupils. Since it is not necessary in this particular course to prepare pupils for college entrance examinations, the program is less academic generally and more functional in nature. Obviously, it is less difficult.

Such specializing courses as special aero-physics, radio, chemistry, and metallurgy are taught in some school systems. At the twelfth-grade level, these specializing courses are offered in the technical schools for pupils who plan to enter technical industries upon graduation or those who wish to pursue science courses in college. Such pupils usually take the regular program in high-school physics and chemistry before electing specializing science.

ENCOURAGING PUPILS TO PURSUE SCIENCE HOBBIES

In addition to pursuing the regular curriculum in science, practically all schools offer opportunities for pupils to pursue science interests and hobbies. In some instances, an opportunity may consist of nothing more than the teacher

and pupils finding extra times at the close of the school day when science hobbies can be explored. In many instances, too, pupils may work with science teachers in arranging effective classroom demonstrations and displays. Some pupils, too, are encouraged to perform experiments far beyond those commonly provided for in the classroom bill-of-fare.

Many types of science clubs are taking root, also, in the various schools. Such science clubs may be completely local in pattern, while in other cases they may be organized as integral parts of formally organized local and national science clubs. For example, science clubs may be identified with local junior academies of science. Such academies are affiliated frequently with the regular state senior academies of science.

Nation-wide, there is an extensive development of Science Clubs of America. Recently, too, a special plan for discovering and guiding science talented youth into careers in science has been visualized. It is hoped that this plan will lead to the organizing of science youth groups. These groups may develop under the title of Future Scientists of America.

ENRICHING SCIENCE TEACHING THROUGH THE USE OF VISUAL, RADIO, AND TELEVISION MATERIALS

Many of the larger school systems of the country now find it possible to introduce an extensive usage of lantern slides and motion pictures into science classrooms. Such slides and pictures are frequently correlated with the units of instruction appearing in organized courses of study. When materials are used in such ways, it greatly increases the effectiveness of science instruction.

Some school systems own their own collections of slides and films. Such slides and films are distributed sometimes by central distributing agencies, perhaps known as divisions of visual education. In other instances, films are owned out-right by school buildings. Such slides and films remain within the school building. Other school systems find it possible to borrow and rent films from commercial film sources. Sometimes the slide and film libraries of state departments of visual education are used.

Some city systems now own and operate local stations for the purpose of broadcasting special lessons by radio to the schools. Science teachers are becoming increasingly alert to the possibilities of teaching science through the use of specially prepared radio lessons. Currently, some school systems are visualizing the possibility of owning and operating their own television stations or of using commercial channels for special television lessons.

WELL-PREPARED SCIENCE TEACHERS ARE NEEDED TODAY

Today, there is a growing demand in larger school systems for teachers who are prepared in more than one of the areas or branches of science. School officials are somewhat reluctant about employing a school teacher who, for example, can teach only biology or only chemistry. Increasingly, it is hoped that teachers

can be found who can teach several or all of the divisions of science. Certainly, a good science teacher, today, would want to have adequate training in biological, physical, earth, and health sciences.

The gap between educational theory and practice needs to be closed. Occasionally, teachers attempt to teach elementary- and secondary-school science in an academic way, somewhat as science was taught to them in some instances in college. Teachers are needed today who are competent in both subject matter and teaching methods. More and more, the trend is toward a functionalized program in science instruction. A program in science instruction cannot be alive and functional unless it is taught by well-prepared teachers.

BROADENING EXPERIENCES FOR SCIENCE TEACHERS

Science teachers today are encouraged to participate in the work of local and national educational and scientific organizations. Through conventions, conferences, workshops, and magazines, teachers are alerted to current problems related to the improvement of instruction in science. Hence, it is not unusual to find a substantial number of science teachers belonging to local councils and academies of science, to state academies, or to such national organizations as the American Association for the Advancement of Science, the National Science Teachers Association, the National Biology Teachers Association, the American Chemical Society, and the American Association of Physics Teachers.

Increasingly, science teachers are finding it desirable to relate instruction in the classroom to pertinent problems of everyday living. Hence, the alert science teacher commonly finds himself co-operating with public health departments, local health organizations, safety organizations, and local industries who provide products or services related to basic science.

WHITHER SCIENCE EDUCATION

The curriculum in science cannot lag behind the impacts of the current social scene. The program in science must continue to be geared to problems associated with living in the world today. With scientific discoveries ever-expanding, and with living becoming more and more complex, the trend towards increasing basic understandings in science should continue. Stress upon practical science for all pupils, but with desirable standards to insure success of gifted pupils when they enter college, will become more and more the pattern. With current shortages of science talent and the growing opinion that much of the nation's future strength will lie in the quantity and quality of its budding scientists, science educators now and in the future must make a more diligent search for science talent and develop avenues and channels for increasing its flow.

F. Science Education in Small High Schools

RICHARD W. SCHULZ

In this article, Mr. Schulz discusses some of the problems of administering and teaching a program of science in a typical smaller high school, and he suggests some specific solutions to these problems. He also describes some of the positive potentialities inherent in the small school science program as well as the blessings which befall the science teacher in such a system.

IT is easy to imagine that the large high school offers to the administrator and to the teacher the ultimate in problems of organizing a program of science education. It is true, of course, that science instruction in a school of 2,000 pupils or more offers a full spectrum of difficulties. But it is also true that science education in a small urban or rural high school involves many of the same problems, as well as some unique to its own kind. In terms of school situations, moreover, the small schools greatly outnumber the large. In 1946, for example, over ninety per cent of the high schools in the United States had fewer than 1,000 pupils, while seventy-five per cent had less than 300 pupils. For the administrator and the science teacher in such small-school situations, it is comforting to understand that colleagues all over the country are facing and resolving the same sorts of difficulties.

Some things are as basic to progress in education as they are to progress in science itself. No scientist can work successfully until he has recognized and clearly defined a problem. Then he must appraise and learn to use his available resources, he must construct an inquiring and experimental program, he must interpret his evidence with an open mind, and he must incorporate in his own activities whatever new ideas he may expose. In like manner, each person concerned with science education must uncover the important problems, and again genuine progress will come only as those educators through initiative and personal sacrifice are willing to pursue a solution.

No reasonable number of words would completely describe science education in smaller schools; for there is great variety in structure, objectives, and methods. However, through some magical product of scientific fantasy, perhaps, we can imagine a composite small school and picture its problems and its unique opportunities. Having identified the problems, we can look to other articles in this publication for more specific trends and suggestions. In education as in science, a complacent attitude will never encourage progress.

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Like sixty-nine per cent of American high schools, the average small school has fifty to 500 students who come from farms, towns, and small cities. It includes grades nine through twelve and is preceded by a regular eight-grade elementary program. Although the traditional science classes are offered, since the small school draws heavily from a rural or semi-rural population, it is not surprising that biology is offered more frequently than general science and twice as often as either chemistry or physics. In many schools, general science and biology are taught in alternate years, and a similar arrangement exists for chemistry and physics. While the smallest schools do not always have facilities for chemistry, the larger schools occasionally provide an applied science for either the slower or the terminal pupils.¹

Since enrollments are small, there is no practicable way to separate those pupils who plan careers in science from those for whom science will be only a means to a better life. In each science class, there is great variety in mental abilities, backgrounds, interests, and goals. About four of every ten graduates will leave their home community for areas of more ample opportunities. The graduates will become farmers, professional people, tradesmen, and home-makers; but high school will be the terminal education for most of them. It is for this reason the objectives of factual knowledge and preparation for college should be carefully re-examined and modified.

A critical ingredient of good science education is the teacher and here the small school faces serious difficulties. Insecurity, inadequate working conditions, and low salaries do not attract and hold the best teachers. These conditions are the more severe in a society where industry and government are vigorously competing for science talent. Many prospective science teachers must decide between education and industry. Experienced teachers are consistently lured to larger school systems as well as to industry and other professions. For all we talk about the intangible rewards in teaching, a salary difference of \$1,000 or more a year can be a most imposing factor. In America's present economic condition, this may well be the major obstacle to enriched science teaching.

In the small schools, two of every three science teachers are working part time in science education. This situation is a product both of small enrollments which preclude more than two or three science classes and of professional backgrounds that represent specialized science patterns for which teacher colleges are partly to blame. In many cases a science teacher is selected for his qualifications in an area other than science. In an age where science is growing and information is accumulating at a phenomenal rate, it is asking much of any adult who has not been trained thoroughly in science to develop a living, useful course in science.

The very heart of science is its method which is universal in value. Learning to secure real evidence, to interpret biased literature, and to establish values

¹ *The Teaching of Science in Public High Schools*, United States Office of Education, Bulletin 1950, No. 9. Superintendent of Documents, Washington 25, D. C. 20 cents.

without preconceived ideas are important skills for any good American citizen. They *are* skills and they must be learned through practice. A functional science program can provide just such practice through opportunities for thorough experimentation and careful investigation. However, this requires equipment and apparatus. In many small schools, there is no way to distinguish the science room from the ordinary classroom; the science laboratory is a product of four walls, twenty-some chairs, chalkboards, an occasional work table or piece of obsolete equipment, and whatever else an ingenious teacher might be able to contribute. A well-prepared science teacher will quite likely provide himself with numerous useful, simple, and inexpensive pieces of equipment which the "general" teacher might never contrive. Although not always provided, a few commercial supplies for demonstrations and individual laboratory work are indispensable to a minimum science program. Other problems in a small school plant are inadequate running water, table or work space, electrical outlets, and ventilation. Many otherwise impossible experiences can be introduced through books or audio-visual aids. While many of the larger schools have libraries or audio-visual programs, they are sometimes weak in science. There is some justification for spending where the largest number of pupils can share the results, but this argument should not operate to the complete exclusion of science.

But whatever his physical environment, a good science teacher must always look ahead to find time for the necessary laboratory chores and preparations. The equipment has to be stored, cleaned, and repaired. A practicable program for securing additional apparatus has to be worked out. Even the most experienced science teacher must experiment continuously with new, more effective demonstrations and laboratory work. It is usually fruitless to hazard an untested demonstration before a discerning class. Finally, to keep abreast of the latest developments in atomic energy, rocket propulsion, antibiotics, and chemical processes, no science teacher can rest on his college experiences. Books and magazines on technical subjects must be read. For all of these additional activities which are somewhat peculiar to science teaching, the science teacher is seldom compensated in terms of money or free time. The result is inevitable, and the small-school teacher for lack of time or preparation settles down to a static and inanimate routine. The heart or the method of science is all too often left to chance learning.

In classes where the range of talent and interest is overwhelming, it is difficult to find time to encourage science talented youth except during after school hours. However, the teacher in the small school must usually compete for after-school time with farm and home responsibilities, with the school bus which icily whisks away the student body soon after the last bell and with motion pictures, radio, television, and automobiles, the very products of science itself. Even the smaller schools and communities often provide a wide assortment of clubs, social entertainment, and part-time jobs. There is an ominous warning from many quarters that boys and girls are being forced to make too many

choices between good things. The vigorous competition for youth's time is imposing support for this argument.

But small-school educators can look to opportunities that are not hopelessly discouraging, for there are some unique advantages. Large enrollments are educational companions of large classes. The small-school enrollments in general science and biology average just over twenty while the average for chemistry and physics is somewhat under twenty.² The teacher has an opportunity to know his pupils as whole human beings in a more personal and informal environment. The pupils' homes, interests, community relationships, ambitions, and aptitudes are more than a counselor's record. They are accessible information and make a cogent teaching resource.

It is the very peculiarities of a small school that make the potentialities for science education so great. The absence of select pupil groups with similar backgrounds and goals invites—no, compels—a science program unspecialized and directed towards the ends of general education. There is no alternative but to help pupils become better citizens, for to organize about college preparation would be to eliminate science from the school curriculum. Instead of looking to a textbook for course material, the teacher can look to his pupils and their community—to their mutual needs and interests. While his pupils may be weak in firsthand experiences with industrial processes and metropolitan life, rural pupils are keenly aware of such problems as erosion, farm safety hazards, sex functions in animals, and the health enemies of man, animals, and plants.

When the science classes are fewer in number and the teachers are not specialists, it is easier to work out a science program where the courses are treated as related subjects rather than independent and specific areas. The possibility of combining physics and chemistry into what has been called physical science may be a practical means to broaden the minimum science program a small high school can offer. That science teachers may have the same pupils for other subjects makes possible an integration of content the larger schools cannot achieve. Atomic energy and its social effects can be studied as a combination unit in science and social science. Other integrations might involve transportation and communication, their scientific explanation and social importance; conservation (since man's resources are limited, as he uses more he must waste less; if man keeps the land, the land will keep man); mathematics, the language of science with its scientific applications; reading and composition where indifferent pupils could sometimes be motivated through scientific materials; and music, so closely related to both sound and electronics.

A good science teacher for all his lack of equipment can work unfettered by the routine bookkeeping of laboratory manuals and subject matter centered science experiments. He can work to develop a balanced experimental program where pupils can work individually or collectively on personal and local problems. A well-prepared teacher should be able to contribute many inexpensive

² *Ibid.*, p. 27.

ideas and to stimulate pupils to bring useful equipment from home. Pupils are willing and usually eager to bring things of science from home or to beg them from friends who are willing to share with the school and the community's youth. In rural communities a natural biological laboratory is frequently just outside the school door or in the pupils' back yards. Every small community is rich in science materials: parks, food markets, commercial shops, industries, farms, mines and quarries, the sky at night, rivers, a weather station, or an airport, to mention a few.

All of these problems and unique advantages invite careful attention from school administrators. Some measures are clearly indicated.

1. The science curriculum must be organized towards the ends of personal development, human relationships, occupational proficiency, and civic responsibilities. This suggests less emphasis be placed on factual knowledge and college preparation.

2. The values of even a small science budget for equipment, room development, reading material, and audio-visual aids should be explained to school administrators and the public.

3. Salaries and working conditions for science teachers must be improved. It is not sufficient to say this is impossible, for it is essential.

4. Provisions should be made for the in-service education of science teachers. The actual problems of science education will be much abated when set upon by well-prepared teachers.

G. Elementary School Science—Implications for High Schools

GLENN O. BLOUGH

In this article, Mr. Blough outlines the present status of—and variations in—elementary-school science education. He then proceeds to suggest to teachers and administrators how they may profit from the increasing science background which high-school pupils bring with them, how they may adapt their science programs to fit.

IT is good to know that many pupils in the United States no longer need to wait to be fourteen or older before school helps them find out what makes it rain, where the sun goes at night, or how plants grow. Beginning with the kindergarten, many schools are now including a study of science as part of the elementary-school curriculum. How universal this practice is no one seems to know and the answer seems to elude investigators, for there is great variation in the kind of science experiences offered, in the way science is worked into the curriculum, and in the amount of time devoted to it. No one can deny, however, that science teaching in the elementary school is growing in amount and quality.

At present there are at least a dozen states that issue separately bound courses of study or bulletins in elementary-school science. Most of the other states de-

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vote considerable space in their general elementary-school publications to the field of science teaching. Within the past five years much of this material has undergone revision or has been newly issued. Much new material is at present in preparation. A large number of cities, towns, villages, and county units have also produced material in the field of elementary-school science. There are several sets of textbooks on the market that develop a science sequence from grades one through nine. Teachers colleges have increased and improved their offerings in science for teachers in the elementary school and the number of teacher workshops and conferences in science held during a school year in this field is legion. These are indications that, although there are still many elementary schools without a well-developed program in science, large numbers of children are having satisfactory experiences in this field. Each year the number increases. Each year school administrators become increasingly aware that the field of science should receive more attention in the elementary school and are taking steps to see that it does.

This increased emphasis on science in the grade school has certain effects on secondary-school science and these effects are bound to increase. But before we consider them we need to look at some of the characteristics of the elementary-science program. Because there is great variation in elementary-school science programs throughout the United States, it is difficult to generalize, but certain conditions and characteristics seem to be almost universally present. For one thing, teachers in the elementary school seem generally *unprepared* to do the kind of science teaching they would like to do. Their science subject matter background is often inadequate; their methods of teaching science weak. This condition, although improving each year, makes for "spotty" teaching. Where teachers are well prepared and interested in science, the teaching is good and pupils enter the junior high school well grounded in science. Where this is not the case, they do not.

Another characteristic of the elementary-science program is the fact that in many cases the teaching is more or less incidental. That is, it is built around questions children ask, current scientific happenings, things children lug to school, or scientific aspects of the rest of the curriculum such as social studies or health education. In such situations as this, there is no telling what a seventh-grade pupil has had in science. No two years are alike; no two schools are alike. Granted that sometimes incidental teaching may result in some highly desirable outcomes, when it constitutes the *entire* program, it produces a most uneven foundation on which to build advanced science work. Fortunately there is a large number of schools which, in addition to such incidental science, also provide a planned program on which future experience in science may be built.

In many cases there is a great deal of reading from books involved in elementary-school science teaching and often there is not as much actual experimenting-to-find-out as one might desire.

What science experiences, then, can the junior and senior high school assume that its new seventh-grade pupils will have had? The answer to this question will not be the same in any two localities. And this is probably as it should be, for standardization in elementary-school science seems undesirable from many standpoints. There are, however, certain directions in which elementary schools are moving with their science programs. A knowledge of them is helpful in relating the elementary to the secondary curriculum. For example, as has already been mentioned, science is gaining a definite place in the elementary-school curriculum. In this science program, the practice of making it a "doing" subject instead of a "reading" one is on the increase; more and more use is being made of the immediate environment through field trips; there is increased emphasis on group planning in setting up and solving problems of significance to the pupils; there is increased use of visual aids and of the many resources of the community.

These are some of the hopeful signs. Still another represents a most healthy development and important for consideration here: *Many schools are involving teachers and administrators from all grades in the elementary school and the junior and the senior high schools in planning a continuous program. In the most forward-looking schools this planning involves all of the related areas of learning and not just the science program.* In these situations, junior high-school teachers are well aware of what they can expect from their new seventh-grade pupils, for they have had a hand in planning the program. Likewise, the elementary-school teachers know what their pupils will encounter later in the way of science experiences, a condition also highly desirable. In some of these schools, provision is made for teachers of various grades throughout the schools to visit each other. In this way, high-school teachers become acquainted with the methods used in the elementary schools and elementary-school teachers see their former pupils in action in advanced classes through this inter-visitation and co-operative planning; thus resulting a better understanding of the problems involved at all levels and a better science program for children and youth.

It is important to emphasize that there will probably never be a total seventh-grade class in which every individual has grown to the extent that all of the teachers involved wish that he had. All of the pupils will not all read equally well, use numbers with equal facility, think equally well, or write and speak with the same facility. This has always been the case, and always will be, because learning in any field is an individual matter. Nor does it help for the teacher at any level to throw up his hands and say, "They can't read, so how can I teach them?" It helps to remember that generally speaking *teachers at all levels* are trying to do a conscientious job of helping pupils learn. Furthermore, the employers who get the product that has come all the way through the elementary school, the junior and the senior high schools, *and* the colleges frequently complain that they must "teach the job from the ground up", a statement that should give *all teachers* at every level pause to wonder!

The problem, then, is for the teacher at seventh-grade level to be willing and able to take the pupils *where they are individually* and move them along their educational growth a year's worth from September to June. This will involve helping slow pupils, providing additional work for superior ones; in other words, it means adapting the science curriculum to fit the individuals taking science.

Six years of science experience for children in a well-organized school where there is 12-year planning will certainly be helpful to junior and senior high-school science teachers. In such schools, pupils will have had experiences in solving science problems, will have performed experiments of many kinds, taken field trips, learned sources of information, become acquainted with many different fields of science such as plant and animal study, astronomy, geology, weather, sound, heat, light, and many others. They should know something about how to set up simple apparatus and how to construct some home-made equipment. Seen from a different perspective, they should have begun to assimilate scientific knowledge, had experience in solving problems through a scientific approach, begun to develop a scientific attitude and to be interested in and appreciative of the scientific aspects of their environment.

But won't this take the edge off our junior high-school science course? Our eighth-grade pupils say, "Oh, we studied magnetism in fifth grade; why do we have it again?" In schools where there is a good science program in the first six grades, this *does* become a problem; but, as has already been pointed out, if there is planning through the twelve years of the school life, the amount of actual repetition of science material will be at a minimum. Good teaching at any level leaves the pupils with the feeling that there is still much to learn about the science problem under consideration and, what is likewise important, it leaves them with a desire to learn more at a later time. When the eighth-grade pupils say that they have studied magnetism, it is interesting to let pupils list the things they feel sure that they know about magnetism. The list is hardly begun before there is complete disagreement about the validity of statements proposed. Then comes the problem of finding out who is correct in his statement and how one can be sure; and the study begins itself, expanding into previously unexplored phases of the study of magnetism.

It is important to note that one's concern for overlapping and "edge-dulling" is focused almost entirely on subject matter. But the fact remains that helping pupils become acquainted with principles and generalizations in subject matter is only *one* of the objectives for teaching science. We also propose, at least in our talk and in the literature, to turn out better problem solvers, more persons with a scientific attitude, with a broadened interest in science, and with an increased appreciation for it. We also hope to identify, encourage, and guide especially talented pupils whose interest in science and ability makes them potential scientists. In accomplishing these objectives, there can scarcely be too much overlapping for they are difficult objectives to attain and there are all

manner of stages of attainment involved in them. Twelve years of school is indeed a short time when we consider accomplishing these ends with boys and girls and young people. Before we get too concerned about over-lapping, we might well take another look at the total outlay of objectives for teaching science and the problem changes complexion considerably. Certainly teachers and administrators owe it to pupils to plan together and to plan with the pupils themselves to insure a challenging, interesting, and inspiring science program. This, among other things, for any specific grade involves taking into account what has gone before and what will happen in the future.

There is still in most places much to be desired in the relationship between high-school and elementary-school teachers in every field. Everyone stands to profit by a closer relationship, and it would seem that this is especially true in the field of science. Elementary-school teachers need much help in their science teaching. Some of it can come from junior and senior high-school teachers. Some of the methods used in elementary-school teaching might well be adapted to fit later grades so the exchange of help can well be in both directions.

Specifically, here are some ways in which trained science teachers from the upper grades have been of help to elementary-school teachers who want to teach more and better science. They have acted as resource persons to whom elementary-school pupils may sometimes go for information on specific problems in science. They have served as consultants to teachers in helping to locate sources of information, suggesting local places to visit, helping to build simple science apparatus and to order some of the apparatus for use in the elementary grades, sharing any unusual specimens or materials that happened to be brought to the high school, checking science books for scientific accuracy, and helping pupils with special science talent to explore fields in which they are interested. These are but a few of the typical ways in which secondary-school teachers have been helpful.

A note of caution may be appropriate here. Since most secondary-school teachers are not entirely familiar with the potentialities of younger children, their contributions are appropriately of a consultative nature, the final decisions for action rests with the elementary pupils and teachers. It is not the sole function of the elementary-science curriculum to prepare pupils for high school. There are many other very important objectives all of which must be kept in mind as the curriculum planning is done.

The growth in understanding gained by all open-minded teachers from all grade levels working together is of surpassing importance. The effectiveness of a continuous science program is directly proportional to the co-operation of the teachers in all grades. Without it, there can be no really effective instructional program for children and youth, neither in science nor in any other aspect of educational endeavor.

H. A Letter to High School Science Teachers from a College Science Teacher

ERIC M. ROGERS

In this article, Professor Rogers suggests some of the changes which many college and university scientists would like to see made in the pattern of secondary-school science instruction. In discussing the objectives of high-school science teaching, he suggests that an understanding of the nature of science is of the utmost importance, both to the future scientists and to the future non-scientist. He points out that teaching of scientific facts and principles in general courses in science should be severely curtailed, and that education along the lines of scientific thinking is beset with grave difficulties. He concludes his article with three specific, practical suggestions to high-school science teachers which should help them move in the directions which he has suggested.

(This is a private letter¹ to my colleagues in high-school science. If I encourage their principals to read it over their shoulders, it is because I plead for certain changes which high-school teachers tell me they could make if their principals understood and gave approval.)

THERE is an ugly rumor that university science teachers are antagonistic and ungrateful to high-school science. I do not believe that. Such an attitude would be stupid as well as rude. We are all in the same business, public school teacher and college professor alike, a great department store supplying science to many millions. But, if all is well in our business, why am I invited to write about the matter? All is not well; our store has many troubles and is badly in need of re-organization. So this is a note of critical questioning and urgent suggestion from one scientist to another.

In real department stores, has not each of us sometimes seen need for reform? Not just the minor defects: the over-stocked department, the druggist occluded from his customers by a barrier of toothbrushes, the listless salesman and the one who enjoys saying "no," the dirty washroom; but major mistakes: the wrong kind of stock, failure to understand the customers, success in leading the customers to poorer taste by some flood of new stock. As educators, we can see these as defects in educational policy on the part of the store.

Are there any major mistakes of policy in *our* business? We are concerned with providing education in science for the people of a great nation, a great civilization, a great world, in which scientific knowledge directly controls the

¹ Parts of this article are drawn from the author's papers on science for general education in college, including Chapter I, in "Science in General Education," Edited by Earl J. McGrath, *American Journal of Physics*, December 17, 1949, pp 532-541; and *Science*, CX December 9, 1949, pp. 599-604.

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manner of living and indirectly exerts a subtle influence on the pattern of thought. In fact, much of the welfare of civilization, and perhaps even its fate, depends on science. Do our science courses educate pupils to understand this dependence? Scientists have a characteristic way of thinking and planning and working, which we call the scientific attitude or scientific method or science itself, that offers intellectual resources and guidance to all pupils. Do our science courses send their pupils out delighted with that understanding of science, and ready to turn it in new directions? Can governors and administrators who have taken our science courses confer intelligently with scientists on the vital problems of our age? In general, does our science teaching in school and college make its proper contribution to general education? Even in the matter of teaching some science, are we meeting pupils' needs and hopes? Youth are thrilled with the idea of scientific experiments and knowledge. Yet adults boast they "never did understand science" or they think of science as a pile of facts to be learnt by rote and scientists as mysterious wizards who dispense their occult lore rather unwillingly. A few pupils come to college still determined to be scientists—but even *they* usually have a strange picture of science as a sort of stamp collection of facts, or else as a game of "getting the right answer." But the majority seem to have lost their interest in science and have gained a headache. The public delight in science fiction is certainly no credit to our teaching. In a way, it is a tragic commentary on our civilization.

In general education, in school and college, we need not start the training of professional scientists (that can be done much faster once the vocation is chosen) we need not try to equip everyone with a lot of scientific knowledge (that can be stored in books or left to the professionals); but we do need to give an understanding of science and its contributions to the intellectual, spiritual, and physical aspects of our lives. Suppose we think of our own children, planning to be non-scientists but taking some science courses as part of their general education. With what questions should we test the "success" of such courses? We should hardly be content to ask: "How many facts have they learned?" Facts are forgotten all too soon. We are more likely to ask: "Can they think scientifically? Do they understand what science is about and how scientists go about their work? Have they a friendly feeling toward science and scientists? Are they likely to read scientific books in later life with enjoyment and understanding? Could they enjoy intellectual discussions with scientists? Could they work with scientific advisers in business or government?"

In asking such questions as parents and educators, we betray some of our educational aims. We need not agree on all our aims, but I think most of us have in common a number of aims and hopes which form a cogent group, demanding quite a different kind of science teaching. Ask *yourself* now, "For what do we teach science?" Whatever the answer, ask it again after a time for thought. In fact, it is a question one should ask oneself far more often than once every year or so. It may bring a strange new interest into one's life as a scientist.

"What are our aims, the real ones which we can reasonably expect to fulfill?" There is no easy answer and no uniform one. While you ponder over it, let me comment on some of the answers given by other people. These fall into three groups:

1. *For content.* We must impart scientific facts and principles.
2. *For "higher virtues,"* such as training in accuracy, critical thinking, scientific honesty, balanced personality, and, of course, scientific method.
3. *For understanding and appreciation of science and scientists,* something that can last usefully through later life. This involves a happy acquaintance with science, some knowledge of scientific material, and some understanding of the methods of scientists.

I suggest that No. 3 should be our paramount aim, that No. 2 is almost unattainable, and that worship of No. 1 is overdone with dire effects on the reputation of science. Many of us concerned with general education in college science believe that No. 1 must be pared down to provide for No. 3. I will return to a detailed discussion of these three groups later.

But what about preparation for college science? Only a fraction of those who learn science in school continue with science in college, and, of these, only a small fraction become professional scientists. On these last specialists, colleges rightly lavish special training and care—all the more reason why high schools need not do so, since later training can work fast and accelerate to cover earlier gaps. But, and there are two important "buts": (a) we have too few scientists and do not want to miss promising candidates; (b) the future specialist needs a good foundation for later rapid training. Such a foundation does not require a great wealth of knowledge, but it absolutely requires a *healthy understanding of the nature of science*—otherwise, there will be wasted time or even good pupils lost from science. And this is also what the first "but" requires, an *understanding feeling for science and scientists* which would give potential future scientists an opportunity to know what they want as a career. It is also what the general non-scientist needs, a *sympathy with science and an appreciation of the way scientists work*. Given these, how easy to encourage later learning and reading, in either layman or specialist!

Then, marvel of marvels, the same thing is wanted for all: *an understanding of science*. Yes, but not at the same level of knowledge or speed of teaching for all. The rare young mathematician who finds differential equations a delight can whiz through physics deriving enjoyment and profit from a wealth of principles and methods, while his brother, to whom algebra is a five-days' horror, needs quite different teaching to gain his allegiance. Even in entrance examinations, pupils who have been taught less but understand well can succeed—and will be welcomed in college. Examinations themselves are changing and many a college scientist is asking for examinations which will not give high marks to candidates who have only been crammed with facts and formulas. Such pupils have much in their attitude to unlearn and may mistake their career in college. In college physics courses, for example, we dread the well-drilled formula-monger and list-learner. He will have much to unlearn in atti-

tude before he sees physics as a sensible mixture of experimenting and reasoning, with imagination leading to increased understanding but kept in check by experimental tests. At best we must educate him out of his attitude. At worst he will fail as a scientist—finding later science quite different, he will make an uncomfortable change of career. We welcome the keen pupil who feels he knows what scientists are, and likes them. Even if he is not fully informed he will prosper.²

We need more scientists, more young people who discover the delights of science and have the ability to pursue them. We trust you to find these promising people and provide the start. They deserve special teaching; though, without it, they can catch up later. If special teaching for the ablest young scientists seems undemocratic, we may turn an anxious glance at athletics. Perhaps it is equally undemocratic to give special coaching to the football squad. Let us suggest that every senior in the school take his place in the football team in rotation, every pupil take a turn in the baseball team. Now return from such unhappy thoughts to the scientists and give the young scientist the coaching he deserves, for his good, the good of science, and the good of mankind.

So much for the future scientist. Essentially, he can look after himself, if only you will find him and encourage him. Let us return to the non-scientists, whose understanding of science can be so valuable. Why do we teach science to them, and what are our realistic aims? Let us look at the three categories of replies in detail.

1. CONTENT

Content *is* useful, in the kitchen, the factory, and in life in general. Any course that aims at teaching real science—not just telling little tales about wonders—must teach a considerable body of facts and principles. But in many courses pupils find the topics crowded and unfinished. Facts are soon forgotten or muddled. Ten years after school, what is left? Certainly not the facts. Even the principles are ill-remembered. (Be realistic, question your own friends). Most of us are loth to omit large pieces of the usual syllabus, partly because we are afraid to fall behind our colleagues, and partly because we believe the topics of the syllabus really are indispensable. Are they valuable if they are not fully understood and remembered? Are they as valuable as we think, anyway? Here are three examples, two flippant and one serious.

a. Does a knowledge of momentum laws make a man a better athlete? (It could, but it doesn't.)

² Most college physics teachers when consulted about changes in school preparation ask for increased emphasis on understanding and no increase in subject matter; but, above all, they ask fervently for better preparation in elementary algebra. Freshmen come to elementary physics courses weak and muddled in algebra, and even afraid of it. The difficulty is not that they have never learnt the needed skills, but that they have forgotten them and have not been warned that college physics will require these skills with finger-tip availability. The requirements are not heavy: simple equations, easy factoring, exponents, operations with fractions, arithmetical percentages, the properties of similar triangles, and ability to distinguish sin, cos, and tan correctly. The difficulty is real. Those of us who start our physics courses with mathematics tests for sectioning know the lamentable facts. Pupils bring us sad stories from school after school, far and wide. A short review of first-year algebra, just before college, should enable an average pupil to obtain a grade one whole letter higher in freshman physics—he needs to use simple mathematical tools quickly and easily, and he would indeed be grateful for them.

b. Is a woman a better (or happier) housewife for knowing that a thermos bottle keeps things hot by reducing heat losses by radiation, convection, and conduction? These are big words, giving a sense of power to the young, but they do little practical or intellectual good. Evaporation, quite as important, is not mentioned because it comes in another chapter. The two things about thermos bottles which are worth knowing are not mentioned either, because they are not science. These are that the inside part is fragile and that new insides can be bought in a drug store.

c. Even the conservation of energy can take a harmful turn for beginners. This *is* a vital piece of teaching in any physical science course, but it needs very delicate introduction. We must explain how it rests on a great body of varied evidence. At the level of high-school and college-freshman physics the principle must be taken largely on faith. Therefore, it should not be used as a panacea to "explain" everything. (Saying that energy explains why trees grow, pulleys work, comets move, *etc. etc.*, is teaching young people witchcraft, the magic of a mysterious word.³)

I do not condemn our teaching of facts and principles—without them we should not be teaching science—but I do suggest it is not so essential as we have thought to crowd them all in. If we omit some, we can discuss the rest more carefully with greater total profit. Our pupils will have time to grasp more fully. Those of us experimenting with such teaching in college courses for general education in science find that we must omit about half the topics of an orthodox course to obtain the time needed for careful discussion and use of the other half to show the nature of science. We are quite unashamed of the fifty per cent loss, because we think we find it offset by a greater gain. I suggest similar treatment of some school courses. Since you and I have much the same objective at heart, I recommend our ruthless example to you.

2. HIGHER VIRTUES

"Higher virtues," as listed above, would indeed be wonderful. But science teaching cannot confer these benefits on pupils unless the training given in science classes can somehow be "transferred" to other fields of study and to life in general. Is this transfer easily made? Transfer of training⁴ is a key question, of vital importance in our present discussion. So here is a short account of the findings of psychologists who have investigated the matter.

"Will students transfer training, in some skill or habit or the use of some idea, from a science course to other studies or to life in general?" This is a vital question. If the answer is "no," our new schemes must relate merely to better training inside a science and offer little promise as a part of general education. If the answer is "yes," our hopes should be grand indeed. In earlier generations, courses in classics, history, mathematics as well as science—in fact most of higher education—claimed cultural values on the ground that their teaching would transfer to many other fields of the student's education and there be retained as part of his general culture. Educators pointed to the high levels of scholarship and culture "produced" by a thorough classical education. In this they seem to have risked some confusion between *post hoc* and *propter hoc*—we might suggest their classical scholars had the intellect and background to succeed anyway. There have been growing doubts about this

³ If you think this an extreme view, note Poincaré's remarks in "Science and Hypothesis."

⁴ Based in part on the *Report on Formal Training* of the Committee of the British Association for the Advancement of Science, reprint No. 25, 1930-31.

hoped-for transfer. Are scientists themselves better for their studies: tidy and systematic in their general life, critical and unbiased in their general thinking?

Since early this century, experimental investigations at first said "no" to our question about transfer, then later studies showed that it can occur to some extent. It certainly does not take place as easily as educators and the general public hoped. If it did not occur at all, higher education would seem almost worthless except for special professional training. Fortunately, there is some transfer—language teaching can improve intellectual skills, mathematics can give a sense of form or give training in careful argument, and so on—but only in certain favorable circumstances. In our present discussion, it is essential to know what these favorable circumstances are and to try to provide them. They seem to be:

1. There must be common ground between the field of the training and the field to which we wish it to transfer; or there must be similarity between the influencing and influenced functions. For example, if we train a student to weigh accurately in a physics laboratory, it is almost certain that this training will transfer to another physics laboratory and he will weigh the more accurately there; it is moderately certain that he will carry his good training to a chemistry laboratory; much less likely that he will carry it to any weighing he does in his own kitchen or in his business; and it is very unlikely that the training in accuracy will reappear as a habit of being accurate in other activities. Another example: training in argument learned in geometry is likely to be transferred to help geometrical studies, not very likely to be transferred to work in physics, unlikely to help the student to think critically about arguments in newspaper advertisements, and very unlikely to make him a better economist. (We can lessen the gloomy doubts expressed in these examples by attending to the other conditions 2 and 3.)

2. Generalization, with hope of transfer, should be encouraged. Making a student aware of his gains in one field, and pointing out their applicability to other fields, can make transfer more likely.

3. An almost essential lubricant for the process of generalization is the emotional attachment (or "sentiment") the student develops—the extent to which he associates feelings of enjoyment, interest, inspiration with his studies. The more he enjoys his science and is inspired by its skills and methods, the more he likes discussing its philosophy, the more likely he is to retain and generalize the teaching. Thus, reverting to our examples, a student who develops a *delight* in accurate weighing, making accuracy almost a minor ideal, may well carry the techniques and attitude of seeking accuracy far and wide in his activities, particularly, if he has been made aware of the possibility and value of this wide transfer. The student who develops skill in geometrical argument *and* feels inspired by the method may well become the clearer lawyer or cleverer economist by the transfer of some of that training.

4. It has been suggested that ease and amount of transfer increase with increasing general intelligence.

3. GIVING AN UNDERSTANDING OF SCIENCE AND SCIENTISTS

With the difficulties of transfer in mind, I am doubtful of the higher-virtue claims of science teaching. I reduce my hopes to "giving an understanding of science and scientists." In this, with some preaching to pupils about transfer and with a mixture of hope and enthusiasm, we can expect profitable gains. How can we teach to promote these more realistic aims? How can you and I, busy with our teaching, change our courses to provide better education for the general pupil?

First, let me remind you that it is the same old science—we do not have to learn new topics, but only perhaps to leave some out. We may need a change in attitude, but that can be started by asking ourselves questions. It can be continued by reading James Bryant Conant's "Science and Common Sense." The historical studies in that excellent book may fall outside our teaching, (though they are a delight to read for ourselves), but the general discussion of the nature of science is of enormous help.

Next, I want to plead with you to *try* reducing the content of your course. Reducing the pressure-to-finish-the-syllabus brings a remarkable benefit to clear explanation and understanding. Try it just for one year, promising to return to the full course if you wish. Your pupils will not suffer; of that I am sure—they will not even be ashamed of patches of ignorance that they are left with, because they will emerge with ability and readiness to read more on their own. Your principal should not mind (any more than the deans of the great universities do) if he knows you are teaching genuine science selected from an over-full field. He would feel foolish indeed if he urged his language teachers to compress five languages into one course. Do not mistake this scheme for a smorgasbord survey of little topics. Far from it; I urge such thorough treatment of what you do teach that pupils learn it with a proud feeling of full possession.

Finally, I want to plead for laboratory work for all, on a simple scale. How can the general citizen understand the scientists' experimenting if he does not himself experience some of its trials and delights? The emphasis needs to be on doing simple things and trying to extract results honestly—not following cookbook instructions with servile care or verifying "what the book says" come what may. With college freshmen, using simple apparatus, we find more time is needed when we relax the old efficiency system of cookbooks and prepared report forms. Simple experiments which pupils were usually driven through in one period now stretch over two or three, with interest and profit. We start experimenting at once, with few instructions. Later we hold a council of war to review progress and to plan improvements. It is then that the experiment grows.

These are merely suggestions, arising from thinking about the general pupil's needs for later life. If they grieve you, I apologize. If they make you feel uneasy, they may yet help your own thinking. Your concern is the same as mine: to maintain the good name of science while teaching some of its knowledge, and to keep young people's minds lively and open to an enjoyment of science.

CHAPTER II

Curriculum Problems and Policies in Science Education

A. Trends in High School General Science

PAUL F. BRANDWEIN

In this article, Dr. Brandwein discusses several different concepts of the term "general science," such as what might be called "exploratory science," "survey of science," "introductory science," *etc.* Next, he draws on his wide experience in the field, concluding that "most school systems in the country have planned or are planning for a general science experience in the junior high-school years—the seventh, eighth, and ninth grade." The bulk of the article is then devoted to a four-step developmental account of the evolution of general science teaching. These steps, as outlined and discussed, are: (1) a survey of subject matter, (2) an aid to understanding the environment, (3) an aid in solving problems of living, and (4) a core-program, including science, designed as an aid in meeting pupils' needs and interests.

WHETHER science is defined as "conceptualization arising from experiment and observation and fruitful of further experiment and observation," as "verified hypotheses" or as "doing one's damndest with one's brain, no holds barred," the word *science* evokes images which tend to make people feel that they are in the same mental geographical area. However, when we say "general science," precisely what do we mean? Teachers of science are inclined to agree, at least in their statements, about what "general science," in a curricular sense, is not. It is not, for instance, biology, chemistry, physics, or physiography. It is not a senior science. In short, it is not a special science and it comes early in the child's educational experience. In educational practice, in a subject matter sense, general science draws its material from all fields in science. As we shall see, to a number of teachers, general science has come to mean an area which draws its material from all of the child's experience, studied from the viewpoint of observation and experiment.

Thus at the very outset we have a range of educational opinion. There are teachers who think it is a waste of time to teach general science, that curricular time is best spent in a special science because the values of science are best

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attained in concentrated study. There are teachers who think that before a child studies any special science, it is well for him to have a broad view of the sciences, that curricular time in science is well spent when an "introductory science" is the threshold of the special sciences. There are teachers who draw their opinion from a basis of observations of the young child's exploratory and curious nature; that nature dictates, it seems to them. Such a course is exploratory and stems from the child's questions and/or experiences. This "exploratory science" differs from "introductory science" in that the former draws upon the children's interests while the latter draws from chosen areas in the special sciences which are then dealt with in an introductory way. There are those who draw their curriculum from modern psychology and find the needs and interests of the child sufficient and, indeed the only source of objectives for a course in general science. These teachers discard the concept of "introductory science" or "general science" and propose that each year be a year dedicated to the growth of the child. A year's growth is the objective, not a year's general science. Thus, such teachers use the "core" approach as a significant device for helping the pupil grow. Here science in its broadest sense is introduced when the teacher and pupils, planning together, find it useful in solving the problems they have set for themselves.

Now where in this variety of curricular schemes are the majority of science teachers in the United States? I draw my notions from these: An examination of the literature of the past twenty years, including questionnaire studies of principles and methods in general science, ten years of teaching a course in methods of teaching general science, discussion over the past ten years with teachers representing the major areas in the United States, an examination of some twenty odd textbooks in general science and trend of their revision during the past twenty years, and a study of courses of study in general science extant in seventeen states scattered over the United States. Taking into consideration the limitation of the method and the observer, the trends I have observed take the following broad and general directions.

Most school systems in the country have planned or are planning for a general science experience in the junior high-school years, the seventh, eighth, and ninth grade. In a growing number of school systems and schools these junior high-school years are extensions of an elementary general science experience, grades one to six. Generally speaking, elementary general science experiences are beginning to mushroom into existence and, if present trends continue, the next decade will see a tremendous growth in elementary general science. This will result in wide changes in current seventh-, eighth-, and ninth-grade science curriculums. Throughout the country there are also "spots" of general science offerings in the tenth, eleventh, and twelfth grades. These are at present purely experimental, or are attempts at meeting the needs of the "slow" learner. In any event, they are too tentative to make any relevant judgments about them at this time.

The elements of curriculum design evident in the seventh, eighth, and ninth grades seem to be these:

There is an attempt to produce an ascending development of concepts through the seventh, eighth, and ninth grades. For instance, if health is taught in general science (and it usually is), then it will be included in every grade but it will also be arranged so that, although fundamental concepts (balanced food pattern, nature of germ disease, *etc.*) are included at all levels, the enrichment is such that increasingly complex development is evident. So in the seventh grade, food pattern may be stressed, the germ nature of disease barely developed, and chemical treatment (antibiotics, hormones) merely mentioned. In the eighth grade, food patterns may be reviewed, the germ nature of disease developed in greater detail, and the chemical treatment of disease developed. In the ninth grade there is a tendency to review food patterns and germ diseases in detail and extend the chemical treatment of disease; in short, an omnibus, even detailed treatment. The pupil who has had three years of science will have been exposed to the conceptualization in health in an ascending spiral.

Similar treatments will be found in the areas of communication and transportation, weather and housing, the nature of chemical change (the atom), the study of the earth's neighbors, food making in plants, conservation, and more recently, heredity. The courses of study offered within any one grade fall generally into four arbitrary groups or types.

The *first*, practically non-existent, but given in a few schools, is the survey type—one term of biology and one term of physical science. It follows the whim of the instructor and is generally introductory to the special sciences which are heavily larded with the traditional college preparatory subject matter.

The *second* type followed the first in the evolution of the general science course and now appears to be in transition toward the third. This second type may be called the "environment centered" course since its major aim seems to be to give the pupil a rational understanding of his environment. Typical units in this course are:

Science, An Aid in Understanding the Environment

Air	Our Living Foes and Friends
Water	The Solar System
Food	Transportation
Sunlight	Communication

"Sunlight" as a unit, generally embodies food making and the energy cycle. "Foes and Friends," generally embodies germ and insect enemies, and friendly amphibians, birds, and mammals—the conservation aspect is generally treated here. "Communication and Transportation" are treatments of man's increasing conquest over the elements of space and time in his environment.

In the "environment centered" course we have one of the first significant attempts in science to build a course around a pervasive aim—understanding

one's environment—rather than around subject matter sequences *per se*. That is, subject matter derived from college courses. Many schools still give this type of course; indeed, it may be surmised that this course design in general science is one of the dominant ones in the United States at present. It would be of value to get complete evidence on this point.

During the development of this type of course teachers began to accumulate experience with the "environment-centered" course, modern concepts of psychology began to permeate educational practice, and the notion of *science as a way of life* gained increasing ascendancy over the idea that it was the knowledge of science, not its goals, which is significant. As a result, teachers leaned toward courses of study which dealt more with the problems of living. Science, they agreed, should help youngsters live the better life not only in helping them understand the environment but also in dealing more with the way man modifies the environment to his own purposes. Moreover, the future of the pupil as a citizen upon whom science had an increasing impact came more and more into consideration. What were the problems which citizens had to solve as they met science in their lives? How were they to solve them? There were questions which appeared to be at the base of what might be called the "man-and-society-centered course."

In this course, teachers are not willing to be restricted to a syllabus which runs from the beginning of the year and ends in a uniform examination. Rather they look for resource units—different ones for different communities. Subject matter *per se* is not the end; it is subject matter which was *significant* for the community—even the world community—as well as for the world. A comparison of common resource units with the units of the environment centered course (see below) clarifies the point. These are not given in any significant order; indeed, examination of courses of study and textbooks shows no definitive order. In general, UNITS A to F are introduced earlier than those following. It must be emphasized that the teacher of this type of course shows great flexibility not only in the choice of his units, but also in the sequence he uses within individual classes.

Science, An Aid in Solving Problems of Man and His Society

- A. *Time and Space* (Emphasis on man's understanding of his universe)
- B. *Man, as a Resource* (A study of man's way of learning, his use of the methods of science)
- C. *Biological Production* (Food supply, reproduction of farm plants and animals, conservation)
- D. *Predicting Weather* (Goes into rain-making, housing)
- E. *Reproduction* (Basis of reproduction of plants and lower animals; this is sometimes part of B)
- F. *Human Behavior* (Habit formation, learning; may be a part of B)
- G. *Harvesting Atoms* (The structure of the atom, splitting the atom, atomic energy)
- H. *Increasing the Life-Span* (Man's use of mutation, preventing of germ and physiological diseases, increasing the life-span)

I. *Doing the World's Work* (Work, energy, horsepower—the entire panoply of machines and engines)

J. *Wire and Wireless* (Man's whole modern scheme of communication—from face-to-face communication to television)

K. *Industrial Processes* (Science and the behemoth of U. S. production)

L. *New Materials* (Sometimes part of E, but concerns itself with synthetic products)

It would be impossible for any one teacher to deal with these units and their different emphases, in one year—one period a day. Hence, there is a choice and a diversity in the curriculum. Although a basic text is chosen, it follows that there is a wide use of supplementary texts, library materials, reports, and many other sources.

An increasing number of studies began to emphasize the "developmental tasks" of youngsters; emerging philosophies gave increased attention to the needs and interests of youngsters; schools began to lend themselves to the notion that they were in the main stream of life and living. Consequently, the general science course began to derive its own goals from the personal goals of young people who are growing and adjusting to each other and to society. Their problems—job getting; coming to terms with their bodies; getting independence from their parents; learning to get along with their age mates of different sexes, different races, and different cultures; developing a world view; developing toward psychological and economic security—and their solution became the reason for existence of the course.

It seemed clear that science alone could not solve these problems—or even a tithe of them. Hence, the "core program" a block of curricular time, three to four periods, in which the youngster, his needs and interests, became the center. His problems are the resource units. This type of course in which general science plays a part might be titled, "Science As An Aid in Meeting A Child's Needs and Interests."

Instead of discrete units such as those mentioned in the "environment-centered" or "man-and-society-centered" course, the units of the "child-centered" course might be derived from a major problem of adjustment; e.g., "Understanding ourselves and our city." In such a course, subject matter recognizable as science, civics, English, art, music, and mathematics are used to solve a problem of living. For instance, "Why do we behave as we do" is a problem which may come into such a course; all areas—civics, English, science (psychology)—enter into the solution of the problem. The teacher is not a teacher of science but is first and foremost a teacher.

In a "core program", it is part of accepted teaching method to plan with the pupils in choosing the kinds of activities of the course. Committees of pupils may arrange the sequence of topics. The teacher is a guide, a chairman at times; always he is there to afford opportunities for youngsters to grow in their relationships to themselves and society. Subject matter is secondary.

Several cautions need be noted. In my experience, such a course does not mean less subject matter; it actually means more. It may also mean different

subject matter for different groups in the class. But the pupils share with each other through reports, projects, exhibits, discussions, and the various means of interchange which is the beneficent result of group planning and skillful guidance.

Neither does the teacher abdicate. Not only does he reconcile differences by furnishing an environment free from threats and free for growth, but he also looks at the needs of the pupils and the requirements of the community and his own life as frames of reference. In this frame, he makes the course meaningful.

This, then, is where the flux seems to be at present. If we accept the arbitrary titles of designs in general science given here, we may roughly graph¹ a situation as follows (time intervals are merely suggestive).

1920—Science, as a Body of Subject Matter

1930—Science, as an Aid in Understanding the Environment

1940—Science, as an Aid in Solving Problems of Man and Society

1950—Science, as an Aid in Meeting a Child's Needs and Interests

Science teaching, like all teaching, has profited from recent developments in the psychology of learning and from improvements in methods and procedures within the classroom. It is a matter of observation that the lecture is used rarely and the discussion method commonly. It is a matter of observation that projects, reports, and individual laboratory work are getting to have a major place in general science. It is also a matter of observation that general science is being used as a guidance period; it is the place where teachers select those who have "science potential" and give them special opportunities for development in their subsequent high-school career; it is also the place where pupils with other abilities or handicaps are selected for special guidance.

It is safe to say that general science is getting to be the basic course in science because the majority of youngsters take it. More and more, teachers and administrators are beginning to accept the fact that general science is a potent educational tool for the development of young people.

¹ These are listed in order of the increasing frequency of their appearance as "points of view."

B. Trends in High School Biology

FRED FITZPATRICK

Prof. Fitzpatrick opens this article with a brief statement of the role which biological science plays in modern living, and the role which it plays in today's concept of general education. Most of the article is devoted to an examination of the antecedents and origins of the present courses in high-school biology. In this treatment, the writer gives special emphasis to the scientific, social, and educational changes which have brought about corresponding developments in the teaching of life science. He closes his article with a series of brief statements about the forces which are affecting present and future trends in biology teaching. These forces include new findings in biology, experimentation in teaching methods, demonstration techniques in teaching, the use of field excursions, the emphasis on functional content in high-school science, and the nature of modern teacher education.

A RECOGNIZABLE portion of our cultural heritage relates to biology. The present fund of biological facts, theories, and concepts was in process of accumulation before men kept written records. In later years, this fund has increased by leaps and bounds as the sub-sciences of physiology, embryology, psychology, ecology, economic biology, genetics, bacteriology, and parasitology have been expanded.

Discoveries of comparatively modern times have made it possible to cope more or less effectively with many diseases. Preventive medicine has given us a modern city in which it is comparatively safe to dwell. We are able to proceed intelligently with the domestication of animals and the cultivation of plants, to apply genetic principles, and to produce varieties well adapted to specific needs. We may forestall or control the activities of a host of competitors such as certain fungi, parasitic protozoa, and insect pests which continue to threaten our material welfare. We are constantly learning more about the environment and the amazing complex of interrelationships existent therein; thus we discover how to make wise use of natural resources, how to participate in the natural economy of community life without hopelessly disrupting the balance in nature, and how to avoid series of disastrous effects which inevitably accompany such disruption. It is somewhat beside the point to suggest that, in common practice, we by no means exploit all that is known, but in this observation we see at least one challenge for modern education.

Biological research has even included the potentialities of bacteriological warfare and has been vitally concerned in studies dealing with the effects of atomic fission. Atomic bombs were the product of physics and engineering re-

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search; but, once they became a reality, a pressing problem was one of potential effects upon plants, animals, and, above all, man. Thus the realm of biological investigation has been extended to include another phase of survival, a phase which may prove to be of vast importance in the world of tomorrow.

In addition, biology has made contributions to changes in human thought patterns. We no longer scan the heavens for signs of impending pestilence. No considerable proportion of the modern population spends its time worrying about supposed witches. While many people retain misconceptions, there are indications that this defect can be substantially reduced by suitable instruction. There is growing conviction that scientific ways of thinking about problems exist, that these patterns of thought may be employed in dealing with many human concerns, that the biological heritage can make an important contribution in such an application, and that the ultimate result may be for the good of all concerned.

BIOLOGY AND GENERAL EDUCATION

The foregoing considerations lead us naturally to contemplation of the potential role of biological knowledge in a program of general education. But first of all we must face the question: "What do we mean by this 'general education' about which so much has been said and written in the past ten or fifteen years?" In attempting to answer, we are faced by the realization that general education has not meant the same thing to all people and at all times. But there appears to be some tendency to agree that "... programs of general education almost invariably attempt in some fashion to restore relevance and coherence to the students' educational experience ... learning should be relevant to human needs, or more specifically to students' needs (however they may be conceived or discovered) and to the necessities of the time (whether they be considered to some degree novel or merely a continuation of the past)"¹ That educational leaders disagree as to more specific objectives and as to methodologies is admitted, but such disagreements are believed to be without the scope of the present discussion.

When we think about biology in relationship to general education, then, we are likely to envisage it in terms of "needs" or "problems." We also are likely to conclude that the potential contribution is fairly obvious; that it includes knowledge that is functional in the sense that it is related to common affairs and concerns; and that it may extend to understanding of various concepts or principles, to the development of certain special skills, and to the genesis of desirable attitudes.

As far as the writer is concerned, the test of efficacy is whether a given fact, concept, skill, or attitude *will contribute to the development of more intelligent behavior*. That such outcomes are attainable has been strongly indicated by the

¹ National Society for the Study of Education, *Fifty-First Yearbook, Part I: General Education*. University of Chicago Press, 1952, p. 6. (Article by T. R. McConnell).

results of studies made by Burnett², Urban³, and Manwell⁴; that they have not always been realized in more generous measure may be assigned to several causes. For one thing, much functional biological knowledge has been acquired in very recent times and has not yet been generally utilized as material of instruction. For another, it is evident that the objectives of biology teaching in the schools have not always been clear or well chosen, and that we have sometimes given lip service to ideals but have failed to provide materials of instruction that would make possible a realization thereof.

In the general education approach it is clear that the training of professional biologists is not the aim of the secondary-school biology course. This course, however, may serve to reveal aptitudes and develop interests of pupils who will engage in specialized training during later phases of their formal educational experience, and from whose ranks the biologists of the next generation may well come. That such a turn of events is desirable, if not imperative, may be gleaned from the Steelman report⁵ to the President, in which the statement is made that "... the indispensable resource for progress in science is an ample supply of highly trained scientists and technicians. As a nation, we face serious shortages in this field."

THE ANTECEDENTS OF SECONDARY-SCHOOL BIOLOGY

Before we attempt to assess the current status of secondary-school biology, it may be well to consider the past, for many things we encounter in the modern world are comprehensible only in historical perspective. Biological offerings of high schools in the United States represent the culmination of a development that has been in progress for over a hundred years. They reflect strongly the influence of modern educational emphases, but they also carry the imprint of some educational theories that have long since been abandoned as over-all guides to instruction. As an example, we reject an outmoded educational theory, but items of so-called subject matter selected according to the tenets of that theory continue to be employed in instruction even though the justification for such employment no longer exists.

THE EARLY DAYS

So when we examine the contemporary scene we may recall that secondary-school instruction in biology had its beginnings in academies of the late eighteenth century. Strictly speaking, there were no biology courses then, or a good deal later; there were, however, courses in three subjects: botany, zoology, and physiology. Thus Christy⁶ notes that the New Salem Academy offered botany

² Burnett, R. W. "Conservation: Focus or Incident in Science Education." *Science Education*, Vol. 28, March, 1944, pp. 82-87.

³ Urban, John. *Behavior Changes Resulting From a Study of Communicable Diseases*. Bureau of Publications, Teachers College, Columbia University, New York, 1943.

⁴ Manwell, E. A. *Health in High School Science*. Edwards Brothers Inc., Ann Arbor, Michigan, 1947.

⁵ Steelman, J. R. *Manpower for Research*. (Vol. 4 of *Science and Public Policy*). U. S. Government Printing Office, Washington, D. C., 1947, p. 1.

⁶ Christy, O. B. *The Development of the Teaching of General Biology in the Secondary Schools*. Peabody Contribution to Education No. 201, Nashville, Tennessee, 1936, pp. 172 and 176.

in 1795 and that the academy at Keene, New Hampshire, did likewise in 1814. Zoological materials under the title "Natural History" were introduced at Wesleyan Academy (Wilbraham, Massachusetts) in 1818, and appeared in the New York City curriculum in 1825. Physiology got off to a somewhat later start.

The first botany and natural history courses were clearly patterned after corresponding college offerings. The botany course soon became a favorite, perhaps because botany was deemed to be an appropriate study for young girls, whereas natural history (and, later, zoology) were not regarded in this light. At any rate, there is evidence to indicate that in the period from 1860 to 1900 over three fourths of American secondary schools offered courses in botany.

Emphasis in the early botany courses was centered upon collecting, identifying, and describing plants—especially flowering plants. Necessarily, a certain amount of morphology was included, but it is obvious that the main interest was taxonomic. This policy was in keeping with college and research procedure of the times; a relatively new environment was being explored, and its many novel items were being subjected to scrutiny for the first time. During the latter part of the nineteenth century, an added aim became the supposed benefits of mental discipline coupled with transfer of training. Correspondingly, the period from 1870 to about 1900 marked the high tide of individual laboratory work and exacting attention to detail. There was also a trend away from taxonomy in favor of morphology.

Meanwhile, natural history and zoology were making some progress toward general acceptance. Taxonomy and related gross anatomy were emphasized, though perhaps not to the extent that characterized the botany course. The natural history phase was an exploratory study, featuring descriptions of animals and their habits, and symbolized by the bewhiskered nature enthusiast who was later to be immortalized in cartoons and comic supplements. Secondary-school offerings were few at first, and from 1860 to 1900 the courses in question were rarely scheduled by more than half of the high schools. After 1850, emphasis began to shift from natural history and taxonomy to comparative anatomy. The latter subject was, of course, well suited to exploitation of formal discipline practices. Nevertheless, the zoology course probably never was as technical as the botany course, and did not involve as much sheer memorization, but this was no virtue during a period when the proponents of formal discipline held sway.

Apparently the first physiology courses came into the academies shortly after 1830. They were primarily courses in anatomy, and a good deal of the physiology with which they were leavened later proved to be error or misconception rather than fact. But these courses prospered after 1860, and were offered by over three fourths of the secondary schools until almost the close of the century. To a lesser degree, physiology also fell under the spell of the formal discipline aim, but of greater adverse consequence was the fact that the course was forced to

function under a growing legal handicap. This resulted from the enactment of laws by the states, prescribing instruction in physiology courses concerned with the use of alcohol, tobacco, tea, coffee, and other items. The various prescriptions left the physiology course in a somewhat awkward situation, since the laws of the various states were not uniform, what was supposed to be true in one state was not necessarily true in another, and, in some cases, prescribed facts were not reconcilable with demonstrable scientific findings.

THE DEVELOPMENT OF GENERAL BIOLOGY

So secondary-school biology, or rather the several courses which represented the area of biological knowledge, came up to the first decade of the new century, in company with other high-school science offerings such as physics and chemistry, to face a real challenge to continued existence. For great changes were in the making on the educational scene. Confidence in the faculty psychology had been rudely shaken, at least along the frontiers of educational research. The secondary-school population was no longer a small and highly selected group, and was becoming less so with each passing year. Standardization of college entrance requirements was in process. New subjects were being added to the secondary-school curriculum and were competing with traditional offerings for pupil favor.

In this situation, critical re-evaluation of aims, objectives, methods, and content became the order of the day, for justification thereof was requisite to survival. Looking back upon this scene, we may conclude that the secondary-school biological courses were not too well prepared to meet the test. As previously noted, the physiology course was in difficulties. Botany and zoology had been dominated by the Linnaean naturalists, to whom taxonomy and such morphology as was essential to taxonomy represented the strongholds of biological knowledge. To be sure, the voices of Louis Pasteur, Charles Darwin, August Henry Weismann, and Johann Gregor Mendel had been heard, but the usual lag between discovery and the incorporation of new materials in common instruction was much in evidence.

The First Biology Courses

Now European college science instructors had begun to recognize the possibilities of a biology course long before this time. Thomas Huxley had introduced such a course in the middle of the nineteenth century, and one of his former pupils established a similar offering at the Johns Hopkins University. In the latter quarter of the century, biology courses were added to the curriculums of various American colleges, and, at the same time, the trend was represented by experimental offerings in some secondary schools. So when the Committee on College Entrance Requirements looked with favor upon the proposal for a high-school biology course, and when a New York syllabus in biology appeared (1905), the great change was under way. This change was ultimately to be of

great significance, because later on it paved the way for converting the high-school biology course to the purposes of general education.

New Types of Biology Courses

Many of the early secondary-school biology courses represented little more than a telescoping of pre-existing botany, zoology, and physiology courses so that they comprised a single offering. But early in the new century, college biologists instituted another controversy as to the respective merits of the traditional "type" and the newer "principles" courses⁷, which was duly followed by repercussions on the secondary-school level. It was not long before "fused" courses following some type of principles pattern began to appear in the high schools. In such "fused" courses it was more or less axiomatic that little or no emphasis should be placed upon "subject-matter boundaries" of botany, zoology, and physiology. These three sciences, however, served as the main sources of facts and concepts. On the secondary level additional teaching materials were "borrowed" from anthropology, psychology, and historical geology, thus tending to make the high-school course somewhat broader in scope than its college counterpart. In both college and high-school courses, there has been a growing tendency to explain life phenomena in terms of physics and chemistry, thus justifying the definition of biology as "the physics and chemistry of life."

One of the initial advantages of the "fused" courses was that they had no previous existence; it was a case of starting with a clean page and selecting appropriate materials of instruction wherever they might be found. Anyone who has worked with course of study revision will recognize the inherent advantage; it is relatively easy to add new materials, but it is difficult to dispose of that which has become entrenched behind tradition.

Relationships with Other Secondary-School Science Courses

So the new biology courses emerged to compete with the older offerings in physiology, botany, and zoology, and with the even newer general science courses after about 1910. For example, biology and general science were ninth-grade offerings in a good many schools. In 1920, the Science Committee of the Commission on the Re-organization of Secondary Education suggested that biology be offered in the ninth grade in 6-3-3 systems and in the tenth grade in 8-4 systems. This recommendation, of course, did not solve all existing problems, but remaining uncertainties were more or less eliminated by a fairly general trend to establish biology as a tenth-grade offering, a trend which has been approved by the two most recent science yearbooks of the National Society for the Study of Education.⁸

⁷ At least two distinct types of "principles" courses have been developed. In one, the materials are grouped about biological functions such as nutrition, circulation, and reproduction; in the other, the grouping centers about biological theories or principles.

⁸ *Thirty-First Yearbook, Part I* (1932) and *Forty-Sixth Yearbook, Part I* (1947). University of Chicago Press, Chicago, Illinois.

Meanwhile progress made by biology courses in comparison with courses in the separate sciences varied according to locality. But by 1920 a movement away from offerings in botany and zoology and toward a general offering in biology was apparent, during the third decade it became substantial, and today courses in botany and zoology are of minor consequence in the national secondary-school picture. During the same period there has been progressive tendency to do away with the double laboratory period which once was an accepted feature of biology courses.

BIOLOGY FOR GENERAL EDUCATION

It would be difficult indeed to assign a date when high-school biology courses first became identified with general education. For that matter, general education itself did not come into existence overnight, but has its roots grounded in older concepts of a liberal education. There can be no doubt, however, that secondary-school biology has been profoundly influenced by general education emphases during the past twenty years, in part by emphases whose philosophic foundation rests upon neo-humanism or eclecticism, but more substantially by emphases associated with instrumentalism.

The first step toward a biology course of a general education flavor was taken when the teachers, in large numbers, began to experiment with the "fused" type of course. Probably the transition was accelerated during the thirties because the concept that science instruction should emphasize the things most closely related to everyday experiences began to receive acceptance.⁹ Changes in the stated objectives of courses of study and textbooks began to appear. In 1934, for instance, Cole¹⁰ stressed the importance of relating biological information to human welfare, "... applying knowledges, skills, experiences, and concepts in life situations . . .," and learning scientific methods and techniques.

Policy Making Reports

It is perhaps appropriate to note at this point that a number of policy making reports undoubtedly have had considerable influence in bringing about changes in secondary-school biology instruction during the past fifteen years. Thus *Science in General Education*¹¹ recommended that science instruction be related to several areas of life experience, a suggestion which was reconcilable with a report of the National Committee on Science Teaching¹² which appeared four years later (1942). Then came the reports of the Educational Policies Commission¹³ and the Harvard Committee¹⁴ in 1944 and 1945. While it must be ad-

⁹ For example, as set forth in the following: National Society for the Study of Education, *Thirty-First Yearbook, Part I: A Program for Teaching Science*. University of Chicago, Chicago, Illinois, 1932, pp. 10 and 50.

¹⁰ Cole, W. E., *Teaching of Biology*. D. Appleton Century Co., New York, 1934.

¹¹ Progressive Education Association, *Science in General Education*. D. Appleton Century Co., New York, 1938.

¹² American Council of Science Teachers, National Committee on Science Teaching, *Science Teaching for Better Living*. National Education Association, Washington, D. C., 1942.

¹³ Education Policies Commission, *Education for All American Youth*. National Education Association, Washington, D. C., 1944.

¹⁴ Harvard Committee, *General Education in a Free Society*. Harvard University Press, Cambridge, Mass., 1945.

mitted that the documents in question did not present recommendations which agreed in all particulars, it can be argued that each of them included items which favored a trend toward a general education emphasis based upon one or another of the existing concepts thereof, and that each of them had some effect upon average science teaching practice in secondary schools.

At any rate, in 1947, the Committee responsible for preparation of the *Forty-sixth Yearbook*¹⁵ looked upon secondary-school biology in a manner that would have been impossible in 1900 and improbable in 1920. As the writer interprets the general objectives of education in science as seen by this Committee, they include the acquisition of functional information and functional concepts, functional understanding of principles, the development of instrumental and problem-solving skills, and the fostering of desirable attitudes, appreciations, and interests. The point is made that there is challenge to select wisely from a wealth of potential instructional material without undue concern for traditional "content" or "mastery" of a subject at the lower levels of educational experience, but with continuous effort to establish and refine a program that will best fit pupils and future citizens to make appropriate choices and decisions. In the emphasis upon *functional* information and understanding, we may note a tendency suggestive of the instrumentalist philosophy.

The General Biology Course in the Last Decade

The time has now come to say that the high-school biology course of today bears little resemblance to the parent course of 1900 or 1910. Its dominant characteristic in the past thirty years has been its fluidity, the degree of its responsiveness to educational trend, and the extent to which it has been adapted to the aims of general education. Such data as is available on the post-World-War II period indicates that this biology for general education course has been making significant gains in offerings and pupil enrollments. In speaking of this course, the *Forty-sixth Yearbook Committee*¹⁶ comments that "... the trend has been toward focusing attention less on the organization of subject matter and more on the results in the lives of the learners." It may be appropriate to comment further that the specific implementation probably has been in large part a substitution of challenging materials for materials that were traditional, but had only tenuous relationship to the realities of experience.

The Impact of Discovery

Having given some thought to educational philosophy and trends, and to the effect of policy making reports, let us turn attention for a moment to another consideration. We may profitably begin by asking the questions: "Why has the secondary-school biology course changed so much during the past thirty years, and why are so many teachers experimenting with new-type offerings today?"

¹⁵ National Society for the Study of Education *Forty-sixth Yearbook, Part I: Science Education in American Schools*. University of Chicago Press, 1947, pp. 28-29.

¹⁶ *Ibid.*, p. 184.

"Are changing educational philosophies alone responsible, or are other forces at work?"

To these questions we probably may assign no final answers. In the opinions of the writer, however, another very potent incentive to change must be recognized. It may be described as *the dynamic nature of research findings in biology*. Since about 1890, these findings, in accelerating tempo, have included less of the purely academic and contemplative, and more that is of obvious applicability to common interest and concerns. Though we, as teachers, may tend to cling to methodologies and materials of instruction which are most familiar to us, the challenge of the newer knowledge has proved irresistible to many, and it seems possible that secondary-school biology might have undergone substantial changes even though educational philosophy and aims had remained static.

The Trend Toward Experimentation in Teaching

In contemplating the phenomena of instruction, it is often difficult, if not impossible, to make a clear-cut distinction between methods and materials, and biological instruction seems to be no exception to this general rule. Any attempt to analyze is further complicated by the apparent fact that there is no clear-cut standard of teaching practice for high-school biology. Rather, there are practices, and these are quite diversified. Secondary-school biology is taught by a variety of instructors, some of whom have had considerable formal education in biology, but including others who were not trained primarily to teach biology. Some of these teachers are relatively free to select their own objectives, materials, and methods; others are required to conform more or less to an established pattern. Some are free to engage in experimental teaching, and others enjoy no such privilege. Some operate in classrooms which are well equipped and supplied, and others must do the best they can in the virtual absence of bare necessities. These factors and others previously mentioned have tended to prevent standardization of teaching procedure, a state of affairs which may have potential virtue.

At any rate, the observer of current practice may find classes taught by the most formalized drill procedure and rather sharply restricted to the study of prescribed content on the one hand, and on the other classes in which there is no predetermined body of content to be learned and procedures generally follow the progressive pattern. Between these two extremes, of course, a variety of other practices with respect to materials and methodology is discernable, each with its group of adherents among biology teachers. It is apparent, however, that with the virtual passing from the scene of double laboratory periods and scheduled individual laboratory work, teaching practices have tended to become less and less formal.

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The Demonstration Method

Does this mean that the laboratory and the experiences of the laboratory have no existence in modern secondary-school biology? Clearly, the answer is *no*, for it may be argued that the classroom tends more and more to become a laboratory, and that, when the individual pupil is encouraged to pursue his own interests and concerns at the existing level of his ability, he will inevitably come in contact with many meaningful laboratory experiences. Meanwhile, the demonstration method of providing laboratory evidences has come to be a common instructional device. In actual practice, such a demonstration may be carried out by a teacher, a pupil, or a group. It creates a situation in which observations can be made—observations which provide data or facts applicable to the solution of some problem. By definition, the demonstration must be pertinent to the proposition under study or investigation; through teacher direction, the pupil should learn how data are obtained, evaluated, and used. Here is excellent opportunity to become familiar with scientific methods, and to foster the development of acceptable attitudes.

As here defined, demonstrations include a wide variety of experiences. Some of them can be performed in the classroom and others, of necessity, take the pupil and the pupil group out into the community. Some are essentially experimental in nature and others are purely observational. Some incorporate the use of audio-visual aids, or information obtained from resource individuals. In a word, when we think of demonstrations in biology, we must reject the old idea that scientific data are obtained only when an experiment ends in an explosion or the ringing of a bell. We must also recognize that, however scientific our approach may be, we are constantly forced to deal with problems and make decisions in the light of incomplete data. This is far from being an ideal situation, but it is a very real and common situation in human affairs, and provides the basis for the rueful comment that "hindsight is better than foresight."

Field Excursions

Field study is recognized as a normal and desirable feature of secondary-school biology instruction today, except possibly in some of the larger population centers where such study involves difficult transportation problems or legal restrictions of one sort or another. Traditionally, such field study has often included excursions to establish institutions such as water purification plants, various laboratories, garbage and sewage disposal plants, museums, botanical gardens, and zoological parks.

Field study, of course, is one phase of demonstration work—a phase that takes the pupil out into the community. Twenty or thirty years ago it was conducted largely on a "geographical tour" basis, but more recently a different approach has been employed by increasing numbers of biology teachers. In this new approach, field (or community) study is planned and carried out because it bears upon some problem whose solution has been undertaken by the

group. In actual experimental teaching situations, such problems have included various phases of community health, the wise use of land, water supply, sewage and garbage disposal, maintenance of the balance in nature, pest control, and many others. Pupils or groups of pupils assume responsibility for seeking desired data, which are then used by the group as a whole in forming conclusions. Actually, of course, the general technique employed is in the nature of an ecological survey, and especially so when we correctly regard the human community as an appropriate subject for ecological study.

The Emphasis Upon Functional Materials

In most of the experimental teaching now in progress, the emphasis upon *functional materials* is apparent. Thus again we note a strong tendency to depart from the academic in the sense that the academic is traditional and to accept the functional in the sense that the functional means data, understandings, and concepts which have relationship to pupil interests, needs, and concerns. The glorification of theory or principle becomes of lesser consequence, and the knowledge presently required for solution or conclusion becomes the stepping stone to a meaningful educational experience.

The Education and the Re-education of Biology Teachers

In the light of the experimental trend in teaching, the education and re-education of biology teachers has been receiving increased attention. In fact, this general proposition in its application to all science teachers was the theme of the Twenty-ninth Conference on the Education of Teachers in Science.¹⁷ It has always been more or less true that much of the formal education in biology of prospective teachers and teachers in service has been concerned with materials which are justified by tradition rather than by potential utility, and become increasing less tolerable to the teacher who is interested in the things which bear important relationship (rather than remote or theoretical relationship) to common life experiences. Now some of the current dissatisfaction can be related to the fact that a good many college courses now taken by secondary-school biology teachers or prospective teachers are specialized courses not primarily designed for the education of such teachers. But the real difficulty lies deeper and involves the science offerings of teacher-education institutions also, for in many of these institutions the science offerings have somehow failed to develop a form and substance which is truly professional.

Some Encouraging Signs

In conclusion, it seems reasonable to state that the *status quo* of secondary-school instruction in biology presents some aspects that are unsatisfactory and others that offer promise. Among the latter is the growing interest in experimental teaching, the evidence from research studies that some of this teaching

¹⁷ See Fitzpatrick, F. L., "The Twenty-Ninth Conference on the Education of Teachers in Science," *Science Education*, Vol. 36, No. 2, March, 1952, p. 73.

is functional, the responsiveness of much instruction to curriculum trends and to recognition of important research findings, and the extent to which biological materials have become a part of the common school offering and have been elected by the pupils.

C. Trends in High School Chemistry

BERNARD JAFFE

In this article, Mr. Jaffe discusses some of the recent, current, and future trends in the instruction of chemistry in high schools. He begins his discussion with an analysis of the forces which tend to produce these changes—forces such as changes in college requirements, the decline of a psychology based on mental discipline, the increasing scope of chemistry, and the growing social significance of chemical processes and products. Among the changes which are discussed are the emergence of the applied chemistry course, the struggle between classroom demonstrations on the one hand and individual laboratory experimentation on the other, trends in high-school chemistry textbooks, and new developments in the historical approach to teaching and learning chemistry.

IF teaching responds to and reflects changes inside and outside the schools, then we should look for significant reforms in the teaching of chemistry during the last twenty years. For the last two decades have seen a continued and unparallelled increase in high-school enrollments, some further illumination of the psychology of learning, and a number of revolutionary advances in chemistry.

Between 1910 and 1930, there was a fourfold increase in the number of pupils enrolled in our secondary schools, and between 1930 and 1950 high-school registration doubled itself to six millions. As a result, our high-school population changed from a small six per cent, fairly selective, almost elite, student body to a large, heterogeneous mass consisting of seventy per cent of all the boys and girls of high-school age. Interestingly enough, the percentage of high-school pupils taking chemistry during all these forty years remained fairly constant. In 1910, 6.9 per cent of the total high-school population, or 51,000 pupils, were enrolled in chemistry courses, and, in 1949, there were 412,400 chemistry pupils, or 7.6 per cent of the total enrollment.¹ Girls accounted for forty-four per cent of the 1949 registration.

Forty years ago chemistry teaching was justified in our high schools primarily on the grounds of its utilitarian nature; it was functional. In addition, educators

¹ *Biennial Survey of Education in the United States, Offerings and Enrollments in High School Subjects, 1948-49*. Federal Security Agency, Office of Education, U. S. Government Printing Office, Washington 25, D. C. 1951.

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believed that it was valuable as mental discipline and that the facts, principles, and skills which were the expected outcomes of chemistry learning could be transferred to other disciplines in later life. Under the benevolent wings of this faculty psychology, chemistry registration was encouraged. These beliefs, however, are no longer so adequately held. As one educator put it: "The findings of modern psychology reveal that a majority of the high-school population is unable to make effective application and transfer of principles now learned in school. It is necessary, therefore, to make the transfer and application as they are being studied. This can be done most effectively by relating the subject matter to the pupil's environment; that is, build learning experiences around problems vital to the life of the learner."² If this statement is sound, and if the deep-seated change in the type and number of pupils filling our secondary schools is recognized, should we not expect to find some very definite differences in today's teaching of high-school chemistry?

The purpose of high-school education most generally advanced today is to help pupils reach their highest potentialities and to participate most fully and effectively in a democratic society. Does the present high-school chemistry course help to accomplish this? Let us look at secondary-school chemistry and see if its present objectives, content, organization, and methodology differ very much from what they were in 1930. Several significant changes are already apparent. First of all, we are now offering more courses of study specially modified to meet the abilities, interests, and needs of the slower pupil, the non-academically minded one, and of others whose formal schooling must end at high-school graduation.

It is still true, of course, that college entrance requirements exert a strong influence on high-school courses in spite of the fact that only twenty per cent of our high-school graduates enter college. It is also true, however, that many colleges now accept modified chemistry courses as an entrance requirement in lieu of the usual college preparatory chemistry course. As a result, more and more boys and girls are enrolling in the applied chemistry courses. These courses which recognize varying abilities and interests put less emphasis on such frightening bogies of the traditional chemistry course as chemical equation writing, chemical calculations, the ionization and electron theories, and the laws of chemical equilibrium, and give greater emphasis on such down-to-earth and simpler areas of knowledge as household and consumer chemistry, the chemistry of cosmetics, stain removal, metallurgy, photography, and the dyeing and bleaching of textiles. The girl who cannot cope with the difficulties of the college-oriented chemistry course of study and must pass a course in chemistry as a requirement for entrance to a training school for nurses will enroll and be successful in an applied chemistry course which practically every nurse's training school in the country will accept in lieu of the more difficult traditional course. The boy who is almost certain to be a failure in the college-oriented

² Hoff, Arthur G. *Secondary School Science Teaching*. Philadelphia 5: Blakiston, 1947.

chemistry course, and yet wants some instruction in simple chemistry because he is thinking of becoming a dental assistant will enroll and be successful in this course of applied chemistry.

With greater job opportunities for both young men and women as laboratory technicians in hospitals, laboratory assistants in public health services, dieticians, cosmeticians, and the like, more of our high-school pupils are looking for service courses in chemistry that might help them in such jobs. Accurate figures for enrollments in such courses throughout the country are not available, but, judging from one area, it must be substantial. In New York City, for example, during the last five years the percentage of pupils taking applied chemistry (an average of 4,800 each year for the last five years) is a little over 33 1/3 per cent of the total number of pupils (14,100 each year) enrolled in the college-oriented (Regents) chemistry classes.

It may well be that this figure might have represented the situation throughout the country if it were not for the fact that one out of every three public secondary schools in the United States has a total high-school enrollment of less than 100 pupils.³ The median regular 4-year public high school enrolls 97 pupils and the median 3-year senior high school has 685 pupils. Obviously, in such schools, more than one type of chemistry course cannot be offered simultaneously. There just are not enough pupils in such schools, and, as a result, the college-oriented program dominates. In a survey conducted by the U. S. Office of Education in 1948, it was shown that in the very small high schools chemistry is not even offered. In the high schools with enrollments of fewer than 100 pupils, less than twenty-five per cent of the pupils in the eleventh grade (the usual place of chemistry) were enrolled in chemistry, while in high schools of all sizes forty per cent were enrolled. Not a single applied chemistry course was reported from high schools whose enrollment was fewer than 300 pupils.⁴

The content of the traditional high-school chemistry course is undergoing a gradual change by virtue of another pressure. The growth of the chemical industry in this country during the last two decades has been phenomenal. Within the last few years, for example, the United States has solved the problems of adequate supplies of synthetic rubber and synthetic gasoline. We can now be completely independent of the oil of Iran and South America and the rubber of Malaya and Africa. We can now make better gasoline from coal and more versatile test-tube rubber than nature can give us. We are unveiling new and better man-made fibers every year. Nylon, dacron, orlon, dynel, and vicara are a few of these that are replacing nature's cotton, silk, and wool. New antibiotics, vitamins, and drugs also continue to come from the chemists' crucibles in ever-increasing numbers. Petro-chemistry, the science of upgrading of low value petroleum hydrocarbons to high value organic compounds, has rushed ahead

³ *High School Staff and Size of Schools*. Circular #3.7. Federal Security Agency, Office of Education. Washington 25, D. C.: U. S. Government Printing Office. 1950.

⁴ *The Teaching of Science in Public High Schools (during 1947-48)*. Bulletin 1950, No. 9. Federal Security Agency, Office of Education. Washington 25, D. C.: U. S. Government Printing Office. 1950.

at a startling pace. In 1925, only six *million* pounds of organic chemicals were made from petroleum; in 1950 this figure leaped to more than seven *billion* pounds.

In 1925, synthetic organic detergents such as Tide and Dreft were non-existent. Today we use one billion pounds of such detergents representing thirty per cent of our total annual soap consumption. The almost explosive expansion of domestic production of new synthetic organic pesticides, herbicides, and defoliants to protect our crops and livestock and do the work on our farms hitherto done by hand or machine is ushering in a new era. In 1946, cotton defoliation was unknown, today it accounts for eight per cent of our total cotton acreage. In the seven years since 1944, the production of such new products as DDT, 2,4-D, 2,4,5-T, and benzene hexachloride has leaped from ten million tons to twenty times this amount.

The successful conversion of underground coal at the mine into a high energy, gaseous fuel that can be transported by pipeline across the country has been successfully achieved within the last year. We have begun to use pure oxygen instead of air in iron and steel making within the last few years. Instead of pampering our blast furnaces with hot air, and spoon-feeding our steel furnaces with common air, we have learned to bubble pure oxygen through our Bessemer and over the glowing beds of our open-hearth furnaces. Finally, our wartime conquest of nuclear fission has placed in our hands a new torrent of concentrated energy which can easily destroy us or raise the living standards of tens of millions of people all over the world.

What has this chemical revolution done to the content of our chemistry course? It has, strangely enough, stopped the trend towards the piling up of fact upon fact and encouraged the trend towards wiser selectivity even in the college-oriented chemistry syllabus. It has forced us into a re-evaluation of content and a realization of the need for a more meaningful course of study. It has given the chemistry course a new look in terms of a greater awareness of the social and economic implications of chemical advance. Boys and girls, surrounded by scores of new products created by chemistry, have a better chance of understanding the impact of science on our society and what they, as individuals, can do to control or modify the effects of that impact which, according to Earl J. McGrath, United States Commissioner of Education, were "all too often practically nil."¹ We have begun to stress the relationship between the growth of chemistry and the changes in our daily lives which have resulted. We have also recognized the need for more knowledge of nuclear fission and atomic energy by an informed public in whose hands must rest the ultimate decision on how this new cataclysmic force will be used.

To make room for this new and comprehensive area of atomic energy and for the other recent developments in chemistry, we have been compelled to do some careful pruning. The core of the high-school chemistry course still remains firm

¹ McGrath, Earl J. "Science in General Education" *Scientific Monthly*, August, 1950.

and meaningful. More and more, however, of the purely descriptive parts of the syllabus, more and more of the essentially technical industrial processes, and more and more of the mountain of cold, antiquated facts—standbys of the mental discipline days—are being eliminated. Last year, for example, a Regents syllabus revision committee of teachers of chemistry in New York City suggested the elimination of "obsolete, technical, and difficult material as well as material too far removed from the student's life." They tentatively proposed the reduction in "the number of industrial processes taught except those that have social significance or social implications." Among the hoary items tagged for abandonment are the allotropic forms of sulfur, the Chamber process for the manufacture of sulfuric acid, the cyanamid method for the manufacture of ammonia, the manufacture of wrought iron, Avogadro's Law, and some chemical arithmetic.

While most of the advances mentioned above are in the realm of advanced organic chemistry, it is still true that they can be presented in such a way as to avoid the difficulties of chemical equations. Said the New York City syllabus committee, "Organic chemistry should be taught with emphasis on broad, cultural aspects to develop the appreciation of organic chemistry in modern living. Formulas and details of processes should not be required."

Organization of topics in the chemistry course has also undergone some modification. The popularity of textbooks which divided the chemistry course into tight units is waning. The effect of this artificial grouping of chemical knowledge resulted in mental indigestion for the pupil and in a straight jacket for the average, not-too-experienced teacher. ("Only in the large schools can the chemistry teacher be a specialist; in the great majority he must also teach any number of other subjects"—so wrote Norris W. Rakestraw, editor of the *Journal of Chemical Education*, in 1949.) The unit treatment seemed logical enough, but created difficult learning situations. For example, two textbooks published within the last ten years each contained an early unit on the tools of chemistry covering forty pages of text. Into this unit, the authors had crowded together, in logical order, the following items: the atomic theory, the laws of definite and multiple proportions, the rules of valence and the writing of formulas, chemical equation writing, determination of molecular weights and moles, simple and true formulas, gram-molecular-volume, percentage composition of compounds, and other chemical calculations. This is a very neatly wrapped package. But the result of devouring such a unit was disastrous. The piling up of forty consecutive pages of so much difficult material produced plenty of failures especially in the early weeks of the term. Today, the trend in organization of subject matter follows the psychological order. Difficult concepts and other hurdles are carefully interspersed throughout the course so that understanding is not permitted to tailspin nor interest to fall too sharply. To-day's chemistry textbooks are more attractive and better illustrated than in former years. Questions are better graded and reading lists richer.

Some change in methodology is also apparent. The trend away from individual laboratory work in favor of the lecture-demonstration method has not been halted. The battle between those who still champion individual laboratory work and those who would substitute the lecture-demonstration method is not over. Some of those demonstration experts who have forsaken pupil laboratory work argue that laboratory work has not fulfilled the purposes for which it had been introduced. It does not train the faculties, it does not increase the powers of reasoning, its disciplinary value in terms of neatness, orderliness, and systematic habits of work has not been established. It is simply another means of helping to memorize cold facts, they insist. Other reasons besides pedagogical ones have also appeared. It is an unnecessarily expensive method of teaching chemistry. It involves large expenditures for laboratories, chemical supplies and equipment, laboratory assistants, and smaller classes made necessary by effective individual laboratory work. War shortages of chemical material helped the proponents of the lecture-demonstration method.

In some places this situation has reached a very sad state. According to two science educators, "Informal, unpublished investigations of recent data have revealed a surprising number of chemistry students who do not perform a single experiment in a year."⁶ This is serious, for to eliminate individual laboratory work is to rob the chemistry course of some of its vital elements. There are many who still believe that it does provide some skills and technical manipulations that are valuable. Pupils do learn something about handling apparatus. Observations are sharpened, and what is even more important, it helps to wean the pupil away from reliance on verbal authority. The swing of the pendulum has brought us too far over to the other side, and it is time that something be done to bring it back to its rightful place which experience and modern psychology believe it should have.

The last and least fully developed trend is the introduction of the historical approach in the study of elementary chemistry. This fresh approach is valuable not only as a motivating and interest-provoking device but also as a means of binding the subject together more tightly and of presenting the science of chemistry as a magnificent human achievement which grew and developed to its present state as a result of the interaction of great minds and social forces.

One of the main objectives of science teaching is to develop the habit of thinking and dealing with problems by what has been called the scientific attitude. It has been generally accepted that science offers the subject matter par excellence for developing this attitude. Every course of study and every textbook in high-school chemistry has recognized the vital importance of the scientific method or methods. Some teachers have presented this as a separate unit of work, others have approached it indirectly through emphasis during individual laboratory or demonstration work and special references to a few case

⁶ Weaver, Elbert C., and Webb, Hanor A. "The Future of High School Chemistry." *Journal of Chemical Education*, August, 1951. See also, Douglass, H. R. *The High School Curriculum*. New York: Ronald Press, 1947.

histories from the story of chemistry. Criticism, however, against unjustified claims of success by these methods has been frequent.

Within the last fifteen or twenty years several science teachers have suggested a different attack on this pressing problem.⁷ They have tried the historical approach to the teaching of chemistry as an exciting way of presenting the scientific attitude and methods of science. They believe that for many pupils an otherwise arid science can be transformed into a vibrant, human drama that might inspire them to greater interest and effort. It could also tie together the sprawling areas of chemical knowledge into a unified story depicting the growth and development of an important branch of physical science. A few of the leading chemistry textbooks in the field already reflect this new approach to some degree. From the general acceptance of these textbooks, it seems fair to conclude that teachers and pupils have taken kindly to it.

A similar attempt to assist pupils to recapture the experience of the pioneers of chemical advance was made some years later by several college teachers, notably President James Conant of Harvard University.⁸ He presented his ideas in 1947 in a book *On Understanding Science*. He joined a panel of science teachers at Harvard that gave an introductory course in science based on a number of case histories in experimental science such as "The Overthrow of the Phlogiston Theory" and "The Development of the Concepts of Temperature and Heat." One member of this group defended this new approach to science teaching recently as follows: "The public's misunderstanding of, and occasionally positive antipathy towards, science and scientists is a bitter reflection on the methods by which we have previously attempted to teach science. There is every reason to consider the possibility that some non-traditional approach to this problem may prove superior to the methods that have been our reliance in the past."⁹ This was written in connection with the teaching, on the college level, of what Dr. Conant has called "the tactics and strategy of science." This method, with some modifications, is the method now being tried on the high-school level. The historical approach follows the spirit of the 1936 report of the Committee on Correlation of High School and College Chemistry of the Division of Chemical Education of the American Chemical Society which declared that, "In the high schools the viewpoint of the chemistry course should be informational, broadening, and cultural as contrasted with the technical, professional, and specialization attitudes which is unavoidable in the colleges."¹⁰ Whether this trend will grow stronger with the years remains to be seen.

⁷ Jaffe, Bernard. "The History of Chemistry and Its Place in the Teaching of High School Chemistry." *Journal of Chemical Education*, August, 1938.

⁸ Conant, James B. *On Understanding Science*. New Haven, Connecticut: Yale University Press, 1947.

⁹ Nash, Leonard K. "An Historical Approach to the Teaching of Science." *Journal of Chemical Education*, March, 1951.

¹⁰ "An Outline of Essentials for a Year of High School Chemistry." Report of the Committee on Correlation of High School with College Chemistry. *Journal of Chemical Education*, April, 1936. See also, *General Education in a Free Society* (Harvard Report). Cambridge, Massachusetts: Harvard University Press, 1945.

D. Trends in High School Physics

R. W. LEFLER

In this article, Professor Lefler statistically describes the present status of physics instruction in American high schools and points out some of the problem areas. He gives particular attention to the problem of preparation of physics teachers, both at the undergraduate and graduate levels. The remainder of the article is devoted to a discussion of the outstanding features of today's high-school physics teaching. In this discussion both the good and the poor aspects of the features are brought to light. Included in this treatment are textbooks and workbooks, classroom demonstration compared to laboratory experimentation, physics apparatus and materials, audio-visual aids to instruction, library resources, community resources, and the physical layout of rooms for instruction in high-school physics.

PHYSICS instruction in the high schools continues to be intended principally for the college-bound pupil with an interest in science. Physics is usually an elective subject offered somewhat more often in the twelfth grade than in the eleventh grade. The mathematics associated with the college preparatory curriculum is often required as prerequisite or coincident study. Boys in physics outnumber the girls by more than two to one.¹ Physics enrolls fewer pupils than does chemistry, the ratio being approximately sixty-three to one hundred.² Physics is offered more often in the smaller high schools than is chemistry.³ Enrollment in physics represents about thirteen per cent of the number of pupils in the eleventh and twelfth grades.⁴ Although physics enrolls a smaller per cent of the pupils in high school than in earlier years, the actual number of pupils taking physics has not changed significantly through the years.

It is important to note here that many schools have established a "double-track" program in science by providing a one-year course in physical science as a part of their general education offering. Pupils with an interest in the physical sciences, but who are not destined for careers in science or engineering, are enrolled in the physical science course. Courses in applied physics are sometimes included for pupils enrolled in vocational curriculums.

Many schools are using screening devices for the early identification of "science-talented" pupils. Guidance personnel in these schools encourage the young people identified through screening technique, to include as much mathematics, chemistry, and physics in their programs of study as is possible.

¹ *The Teaching of Science in the Public High Schools*, Bulletin 1950, No. 9, Federal Security Agency, Office of Education, Washington, D. C., p. 6.

² *Ibid.*, p. 6.

³ *Ibid.*, p. 18.

⁴ *Ibid.*, p. 18.

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Programs providing awards for "science-talented" youth, sponsored by voluntary groups not directly associated with our educational systems, are providing encouragement for continued study in the high-school sciences through chemistry and physics. Examples of these programs are the Westinghouse Science Talent Search, the American Society of Metals Award conducted by the National Science Teachers Association, and the Bausch and Lomb Award.

TEACHER TRAINING

The problem of staffing our physics classrooms with adequately prepared teachers continues to be a grave one. The trend in many states now follows a set of recommendations first made by the AAAS Co-operative Committee on the Teaching of Science;⁵ namely,

A policy of certification in closely related subjects within the broad area of the sciences and mathematics should be established and put into practice.

Approximately one half of the prospective teacher's four-year college program should be devoted to courses in the sciences.

Colleges and certification authorities should work toward a five-year program for the preparation of high-school teachers.

Curriculum improvements in the small high school should go hand in hand with improvement in teacher preparation.

These recommendations were again emphasized in the report on "The Present Effectiveness of our Schools in the Training of Scientists"⁶ prepared by the Co-operative Committee at the request of the President's Scientific Research Board.

Where the above recommendations for certification are put into effect, teachers of science are prepared with sufficient breadth to teach; for example, physics, chemistry, general science, and mathematics. In addition, sufficient depth, a minimum of twenty semester hours, is assured in each science area to insure reasonable teaching competence. School administrators are now challenged to plan teaching schedules to take advantage of and to encourage certification in related areas.

Edward F. Porthoff⁷ conducted a study of the teaching combinations of 3,490 teachers in 525 public four-year accredited secondary schools of Illinois having less than twenty teachers on the faculty. Of 325 teachers of physics, none were teaching physics only, thirty-four per cent taught physics and one other subject, forty-five per cent taught two other subjects, and seventeen per cent three other subjects. These teachers taught 111 different combinations and twenty-three subjects. It seems unlikely that we can prepare teachers adequately for the conditions indicated in the above study; however, a teacher with twenty semester hours training each in mathematics, chemistry, and physics and with basic

⁵ "The Preparation of High School Science and Mathematics Teachers," Report No. 4, The AAAS Co-operative Committee on Science Teaching, *School Science and Mathematics*, February, 1946, pp. 107-118.

⁶ "Manpower for Research," vol. 4 of *Science and Public Policy*, A Report to the President by the President's Scientific Research Board, October 11, 1947. U. S. Government Printing Office, Washington 25, D. C.

⁷ Porthoff, Edward F. "Combinations Taught by Teachers in Certain High Schools in Illinois," mimeographed report furnished to K. Lark-Horovitz, by courtesy of the author.

courses in biology and possibly geology and astronomy can fill a definite position as a science and mathematics teacher.

There is now a trend toward providing subject matter courses in science and mathematics tailored to meet the needs of the teacher and offered at such times as to encourage the teacher to complete his fifth year of study in his teaching field rather than wholly in the department of education meeting requirements for a school administrator's certificate, or just taking courses to meet salary schedule requirements. These science courses are based on the teacher's background of approximately twenty semester hours of undergraduate study in the specific science and are planned co-operatively by the subject matter departments as, for example, mathematics, chemistry, and physics working with the school of education. Approximately ten semester hours of work in each subject area—mathematics, chemistry, and physics—might be included in the plan of study which could also include a three- to six-semester hour research paper in some phase of science associated with instruction or six semester hours in suitable professional courses in education. This non-thesis option would lead to a Master's degree in science teaching.

The support of school administrators for this or a similar program of study for in-service teachers of science will aid materially in the improvement of classroom instruction. While it is agreed that basic courses in instructional procedure are essential, good instruction is also very closely related to knowledge and experience in the subject area. Too many teachers have terminated their formal education in science subject matter with the undergraduate courses.

A number of industrial concerns have established in-service summer training programs for physics teachers in co-operation with colleges. Notable among these is the General Electric-Union College program at Schenectady and the General Electric-Case Institute program at Cleveland. These programs provide study in the college and experience in the research laboratories of the companies. All-expense scholarships are provided to physics teachers selected to attend these institutes. The Westinghouse Corporation sponsors a similar scholarship program of in-service training in co-operation with the Massachusetts Institute of Technology. It is to be hoped that industry will be encouraged to extend this type program for the improvement of science instruction.

Science teacher's "workshops" with equipment, supplies, tools, books, and periodicals have been established in a number of colleges, among which are Boston University, Harvard Graduate School of Education, Ohio State University, and Purdue University. In the latter instance, open house is held monthly for in-service teachers of physics. These open-house days provide for browsing through the 1,000 volume library, among the thirty-odd periodicals, and through the several file drawers of bulletins and charts produced by industry. In addition, teachers may construct or repair apparatus or they may take materials into their own schools on a library loan basis to determine the suitability of any given piece of equipment for their laboratory situation. Here teachers of physics come

together informally to discuss their common problems and to seek new ideas in physics instruction.

PROFESSIONAL ORGANIZATION MEMBERSHIP

From a professional point of view, teachers of science do not strongly support science teacher organizations or subscribe to or read professional journals in science and science teaching to an extent comparable to persons working in other professions. Johnson has estimated the number of science teachers in public high schools to be about 62,000, as of 1948.⁸ The number of teachers belonging to all the leading science teacher organizations of state-wide or national scope is probably less than one third of this estimated number of science teachers, and this total includes many teachers with membership in from two to five of these organizations. Fletcher Watson⁹ has submitted a questionnaire to all science teachers in the public secondary schools of Massachusetts to obtain information regarding certain characteristics of these teachers. Replies were received from 316 teachers from 157 of the 259 schools. These 316 people held only forty-four memberships in the following national societies concerned with science and mathematics: the National Science Teachers Association, the American Association for the Advancement of Science, the American Chemical Society, the National Association for Research in Science Teaching, and the National Council of Teachers of Mathematics. They held a total of 116 memberships in local science teacher groups. If no person belonged to more than one society, only fifty per cent of the group replying hold membership in a professional science teacher or scientist group. It is likely that the teachers who did not reply from the 102 schools would show even less professional interest. Of the 316 reporting, 111 belong to no professional society, not even the Massachusetts Teachers Federation or the National Education Association.

Of seven important recent publications dealing with science instruction, such as *Education for all American Youth* and *Science, the Endless Frontier*, one fourth of the teachers reporting have read none, and seventy of these teachers read no professional journal at all.

It would seem fair to conclude that high-school physics teachers as a group are no more or no less interested in professional growth through meetings and journals than are science teachers as a whole. School administrators should lend encouragement through providing for travel and time for teachers to attend professional meetings in their teaching fields. College science departments in the region will usually be happy to co-operate in making both staff and facilities available for teacher improvement programs. Teachers in a given school might be encouraged to pool their resources to provide a professional library of books and periodicals. School memberships might be possible in many of the professional societies.

⁸ *The Teaching of Science in Public High Schools*, Op. cit., p. 24.

⁹ Watson, Fletcher G. "Who Teaches Science in Massachusetts", *Harvard Educational Review*, Vol. 19, No. 3, 1949, p. 147.

THE TEXTBOOK

The greatest single influence on the content and presentation of physics is the textbook. A review of the contents of *A School Compendium of Natural and Experimental Philosophy* written by Richard Green Parker, Principal of the Johnson Grammar School, Boston, in 1856 reveals the following content:

- Matter and Its Properties
- Gravity
- The Laws of Motion
- The Mechanical Powers
- Regulators of Motion, Pendulum, Governor
- Hydrostatics
- Hydraulics
- Pneumatics
- Acoustics
- Pyronomics
- The Steam Engine
- Optics
- Electricity
- Voltaic Electricity
- Magnetism
- Electro-magnetism
- The Electro-magnetic Telegraph
- The Electrotype Process
- Magneto-electricity
- Thermo-electricity
- Astronomy

Reference to our modern texts indicate much the same coverage of physics with additional material in each area to include knowledge gained during the intervening one hundred years. Additional topics which are to be found in current high-school physics texts treat of: molecules—their behavior, electronics, radio, television, X-rays, radioactivity, nuclear energy, and transportation, including the study of the automobile and airplane.

The Parker text of one hundred years ago consists of a series of nearly 1,400 numbered paragraphs each presenting a fact or principle, as for example:

How does the electro-magnetic current act?—The action of the conducting-wire in these cases exhibits a remarkable peculiarity. All other known forces exerted between two points act in the direction of a straight line connecting these points, and such is the case with electrical and magnetic actions, separately considered; but the electric current exerts its magnetic influence laterally, at right angles to its own course. Nor does the magnetic pole move either directly towards or directly from the conducting-wire, but tends to revolve around it without changing its distance. Hence, the force must be considered as acting in the direction of a *tangent* to the circle in which the magnetic pole would move.¹⁰

This book seems particularly well adapted to a situation where the pupil would "learn" the material presented in an assigned sequence of paragraphs and then during recitation quote the material almost verbatim to the teacher.

¹⁰ *Parker's Philosophy*, Revised Edition, A. S. Barnes and Co., New York, 1856, paragraph 1149, p. 311.

The modern text retains much of the content of the text of one hundred years ago, for the importance of these fundamental concepts of mechanics, light, heat, sound, and electricity has only been emphasized by the discoveries in modern physics. In addition, the modern text presents the principles more recently discovered and included under the heading "modern physics."

Inductive methods are prevalent in current texts. Starting with the familiar and the commonplace, the pupil is led to the formulation of the basic laws of physics. Emphasis is placed on unifying aspects of physics; as, for example, the manifestation and transformation of energy—the conventional units of mechanics, heat, *etc.*,—are shown to be interrelated and not "watertight" compartments. Stress is placed on "Things to Do" to encourage teacher demonstration and pupil experimentation.

Rarely can the teacher of physics, today, cover the content of the entire text unless he goes back to the questionable methods of previous years where the pupil is expected to "learn" the material of the text in sequence for "quoting" back during recitation. Where emphasis is placed on the development of ideas, on the consequence and social impact of these ideas, on the methods of experimental science and of the scientist, on learning through individual study and experimentation, less content will, in general, be covered but the pupil gains confidence in his ability for learning after formal education has ceased. The teacher under these conditions makes selections as to content to be studied intensively and provides appropriate interlinkage between the "blocks" of intensive study.¹¹

THE WORKBOOK

The use of a workbook is a custom *most honored in observance* and in some cases may be desirable, for a well-prepared workbook can aid the pupil to identify the important aspects of the assignment, can lead him to deduct applications of principles not set forth in the text, and can, in general, serve as a valuable guide to study. Workbooks which possess blanks which can be filled in mechanically by locating appropriate phrases in the text are to be deplored, for here the pupil has a false sense of "having done his lesson" when the blanks are filled.

The author has witnessed period after period of "recitation" where the teacher has held the "teacher's" copy of the workbook and where pupil upon pupil was called upon to "guess" the wordage which the author of the workbook had used in filling in the blanks in the copy held by the teacher. Such periods were almost completely lacking in enthusiasm for science, in the stimulation of thought, or in acquainting pupils with the methods and procedures of science. School administrators and supervisors should note particularly the manner in

¹¹ Eric Rogers of the Department of Physics of Princeton University first proposed the block-and-gap idea. Hatch and Cope have discussed the flashback technique as associated with the block-and-gap method in an article appearing in the *American Journal of Physics*, March, 1951, pp. 137-145.

which workbooks are used and, where advisable, give the teacher counsel in the wise use of the workbook or even advise its elimination in certain cases.

DEMONSTRATION OR LABORATORY TEACHING?

The desirability and need for observation and experiment to achieve the objectives of science instruction are self-evident. The relative effectiveness of pupil experiment as compared with demonstration experiment has been studied without arriving at conclusive results; however, there is evidence that demonstration experiments provide an effective and often economical way of achieving many of the objectives of science teaching. Demonstrations do not provide opportunity for the pupil to develop laboratory skills, to explore his own interests, or to develop a true appreciation of the method of science. Both teacher demonstration and individual pupil laboratory are needed in high-school physics.¹²

The teacher demonstration¹³, a much-used technique in physics, can raise problems and help to solve them, and can provide firsthand data as a basis for answering questions which arise during discussion periods. Demonstrations provide the opportunity for pupils to observe experiments and collect data through the use of instruments which only a skilled person can operate or which are too costly to be provided for each student laboratory group. A series of demonstrations can be used in an effective learning sequence or as a review of concepts associated with a unit of instruction.

The reader is referred to Part I of the recent book, *Methods and Materials for Teaching General and Physical Science* by Richardson and Cahoon,¹⁴ for a good treatment on planning and using apparatus and materials for demonstration and laboratory teaching. This book is a *must* in the professional library of every teacher of physical and general science.

Individual laboratory experimentation provides essential firsthand experience with natural phenomena. It enables pupils to obtain answers to problems by the methods of science. It shifts the focus of activity from passive observation to active participation. It trains the powers of observation and develops skills in co-ordination and manipulation. It provides opportunity for developing resourcefulness in the use of physical materials and instruments.¹⁵

Although the conventional laboratory manual still serves extensively as a guide to pupil experiments to be performed, many teachers are breaking away from the "cookbook" nature of the exercise and from the habit of having all pupils do exactly the same exercise at the same time. The trend is toward identifying a problem of interest to the pupil which is solvable with apparatus available, and then attacking this problem by varying methods as they work individually or in small groups.

¹² "Manpower for Research," *Op. cit.*, p. 91.

¹³ Sutton, Richard M. *Demonstration Experiments in Physics*, McGraw-Hill Book Company, New York, 1938, is a *must* in the professional library of the physics teacher. Although it includes ideas for college level instruction, approximately 60 per cent of the demonstrations described fit effectively into high-school instruction.

¹⁴ Published by McGraw-Hill, New York, New York, 1951.

¹⁵ For a discussion of the use of the laboratory, see R. W. Lefler, "The Teaching of Laboratory Work in High School Physics," *School Science and Mathematics*, June, 1947, p. 531.

Many of the laboratory exercises appearing in the manuals, such as plotting a magnetic field or finding the focal length of a lens, may be done by the pupil as he makes his regular preparation either in supervised study or at home. This means that apparatus should be available to him on a library loan basis, as are books. Pupils are encouraged to do home study where they have the equipment available to carry out the simpler experiments suggested in the text. Better preparation and familiarity with the basic experiments release time for more advanced work and for individual junior research activity in the laboratory. Moreover, the school which uses its scientific apparatus "around the clock" can justify its investment more nearly than can the school where the apparatus is kept locked in the cabinets. Most pupils in physics have enough seriousness of purpose to assume responsibility for apparatus once they have been taught how to use it.

MAINTAINING THE PHYSICS LABORATORY

Apparatus used in high-school physics should include the simplest type, consistent with adequate presentation of principles, and also specialized equipment to challenge and interest the gifted pupils. Tools and raw materials are essential in order that both teacher and pupils can make, repair, and adjust apparatus.

An annual budget is usually established for equipment and supplies. This makes it possible for a teacher to plan with the school administration for the long-range and continuous development of the laboratory.

"*A Report to the Department of State on Science Course Content and Teaching Apparatus Used in Schools and Colleges of the United States*"¹⁶ contains apparatus lists which reflect representative practice in the schools of the United States where effective science teaching is found. The total amount of the inventory for physics was at that time \$2,500. Currently the amount would probably approach \$3,200. The inventory for schools having classes smaller than twenty-four pupils would be somewhat less, but the amount would not reduce in proportion to class size because of the cost of demonstration apparatus. Large schools with more than one class per period would require a larger inventory. These lists did not include apparatus for the encouragement of extra-class junior research activity in physics; therefore, no school should consider the laboratory completed when the dollar value of the inventory reaches the above estimates. Long-range planning will reduce the possibility for the haphazard development which renders expensive pieces of equipment of little value because of the lack of supporting equipment. Providing equipment for junior research activity is just as important as providing instruments for the band, books for the library, or athletic supplies for the teams.

¹⁶ Prepared in 1946 by the National Science Teachers Association and the Cooperative Committee on Science and Mathematics Teaching of the American Association for the Advancement of Science.

Effective physics teaching requires that the laboratory be open at the end of the school day for junior research activity. The equipment and supplies should be available for laboratory and home use. Obviously, the teacher always assures himself as to the ability of the pupil to use each piece of equipment before charging it out for home use. Encouragement of the potential scientist and engineer is the ambition of every effective physics teacher.

Physics requires both qualitative and quantitative expression. An understanding of physics involves the ability to understand and use arithmetic, algebraic, and geometric expression. Problem solving is an essential part of modern physics teaching.

The use of visual materials is especially important in the interpretation of physical principles. Demonstration and laboratory devices have been discussed earlier. Charts, models, lantern slides, filmstrips, and motion picture film are all adapted for use in physics instruction. The motion picture film is especially useful where animation can help the pupil visualize a phenomena; as for instance, the growth of a magnetic field associated with an increasing electric current.

Writing projectors of the "visual-cast" variety are particularly useful for projecting demonstrations which must be conducted with small-size apparatus as in the case of electro-chemical effects, magnetic and electric fields. Large size slides for use with the overhead projector may be made by drawing on transparent plastic sheets which may be filed for future use.

The film loop, which is made by joining the ends of a strip of motion picture film depicting one cycle of a physical action, such as electromagnetic induction or simple harmonic motion, is just coming into use. These loops will be relatively inexpensive, will be a part of the equipment of the school, and thus be immediately available for use when needed.

THE REFERENCE TABLE

Co-operation between the physics teacher and librarian is essential in the development of a library of periodicals and books both for the encouragement of free reading and for reference work. One of our purposes should be to aid the pupil to become as nearly as possible "sufficient unto himself." To do this effectively, teachers of physics work at a program for the encouragement of good reading habits in physics and science. A reading table is a part of each laboratory. Current science periodicals, selected books, and literature produced by industry are to be found here. Industrial materials provided through the packet service of the National Science Teachers Association or listed in the *Science Club Sponsors' Handbook*¹⁷ are suitable for this reading table and aid in relating physical principles to practical applications.

SCHOOL AND COMMUNITY

Greater emphasis has recently been placed on the use of community resources. Business—Industry—Education days have encouraged closer relations

¹⁷ Available to club sponsors from Science Service, 1719 N Street, N. W., Washington 6, D. C.

of school and community. Specialists in the community sometimes take part in physics classes as consultants during the study of areas of work related to their field of specialization. They contribute to the class discussion from their background of experience but they do not replace the teacher or lecture to the group.

THE PHYSICS CLASSROOM

The single room designed for all class and laboratory activities in physics is now taking precedence over the dual arrangement of separate laboratory and class or lecture room. An extensive report on "School Facilities for Science Instruction" is now in its second draft and should be published during the next year. This report has been written by a committee of the National Science Teachers Association and includes a very complete chapter on physics rooms and facilities.

In addition to teaching facts and principles, physics teachers attempt: to aid in making communication easier between the scientist and the layman; to help the pupil learn how to formulate a good hypothesis; to help him to recognize the basis for validity of theory; to cause him to be intellectually honest; and aid him in formulating a picture of the scientist and to distinguish between the scientist and the non-scientist.

E. Trends in High School Courses in Integrated Physical Science

H. EMMETT BROWN

In this article, Dr. Brown turns his attention to a relative newcomer in the field of science instruction—the course in integrated physical science. Statistically, he describes the present occurrence of courses of this kind in this country, and then attempts to account for the fact that its occurrence, although small, seems quite definitely to be increasing. Turning to the physical science course itself, he outlines typical objectives, characteristics, and content of such courses with specific examples, typical methods used in these courses, and criteria for evaluating the effectiveness of the courses. Finally, the problems of the textbook in integrated physical science are brought to focus, and certain specific suggestions for the preparation of such a text are offered. The article is concluded with a summary.

THE story of the teaching of integrated physical science courses in the schools of the United States over the last twenty years is one of rapid change, particularly in respect to enrollment. Prior to World War II, it was reported¹

¹ "The Course in Physical Science", p. 190 in *Science Education in American Schools*. Forty-Sixth Yearbook of the National Society for the Study of Education, Part I. Chicago: University of Chicago Press, 1946.

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that there were over 7,000 students enrolled in such courses in California alone. In 1940, Watson² stated that they were being offered by schools in fifty-four cities of over 25,000 population located in twenty-six different states. The war changed all that. Physical sciences virtually disappeared from the high schools, to be replaced in large measure by special war-oriented courses.

Carleton³ believes however that at the present time such courses are "on the way back." Numbers are, however, still small. The U. S. Office of Education⁴ reports that there were only about 7,000 pupils enrolled in courses offered in twenty-one states in 1948-1949. Of 506 non-science-curriculum pupils entering San Francisco State College in a recent year, only nineteen or 3.75 per cent offered "general physical science" for admission, while nearly 57 per cent offered chemistry and 29 per cent offered physics⁵. The figure for physical science was the lowest of any of the science mentioned in the report.

A study by Johnson⁶ in 1947-8 in which he studied a "stratified random sample" of 755 (of the 23,947) public high schools lists only seven schools giving physical science courses. However, he notes the number of courses of "the physical science type (which) may indicate that schools were searching for science offerings to interest pupils who did not elect the usual chemistry and physics courses."

VALUE OF INTEGRATED PHYSICAL SCIENCE COURSES

But if integrated physical science courses are on the increase (even though present enrollment may be small) why is this true? Let us note five reasons:

1. There has been an emphasis in recent years on general education at both the high-school and college level. Integrated physical science courses are thought by many to serve this general education function better than do separate courses in physics and chemistry. The 46th Yearbook of the National Society for the Study of Education⁷ emphasizes this point when it quotes from the Harvard Report, *General Education in a Free Society*: "Science instruction should be characterized by broad integrative elements . . ." and further cites the Harvard recommendation for an integrated physical science course that gives "a systematic presentation of concepts and principles of the physical sciences."

2. The integration of the older separate biological sciences into modern high-school biology has been a most desirable development. Consequently, many people, e.g., Johnson,⁸ feel that a parallel integration of the physical sciences would be desirable also.

² Watson, Donald R. "A Comparison of the Growth of Survey Courses in Physical Science in High Schools and in Colleges." *Science Education*, vol. 24, pp. 14-20, 1940 (January).

³ "The Course in Physical Science," *Op. cit.*

⁴ *Biennial Survey of Education in the United States—1948-1949*. Chpt. 5, "Offerings and Enrollments in High-School Subjects." Washington, D. C.: Supt. of Documents, 1950.

⁵ Morse, Stanley W. "High School Science Experiences of 506 Non-Science Curricula College Students." *Science Education*, vol. 34, pp. 117-126, 1950 (March).

⁶ Johnson, Philip G. *The Teaching of Science in Public High Schools*. Washington, D. C.: Supt. of Documents, 1950.

⁷ "The Course in Physical Science," *Op. cit.*

⁸ Johnson, Philip G. "Adaptations of the Physical Sciences to the Needs of Secondary School Pupils." *American Journal of Physics*, vol. 15, pp. 480-483, 1947 (November).

3. An integrated physical science course may well attract pupils who would ordinarily not enroll in a physical science at all (Keirstead⁹), or serve as an excellent introductory course for pupils who will elect special courses in chemistry or physics in the following year.¹⁰

4. Colleges are generally recognizing such courses as suitable for admission purposes.¹¹ Carleton¹² queried ninety-five colleges concerning their willingness to accredit such courses and found none which would not approve them (although 19 of the 95 did not reply). Carleton concludes that "Colleges are more inclined to be liberal in the nature and variety of secondary-school courses which they will accept as entrance units than many secondary-school teachers, counselors, and administrators give them credit for."

5. Some school officials are commencing to "get behind" the physical science "movement." Thus E. S. Braefield, Director of Instruction in Mississippi¹³ states that "a course in general physical science has a place . . . at the eleventh- and twelfth-grade level. . . . In Mississippi we are recommending general physical science for both our large and small high schools."

OBJECTIVES OF INTEGRATED PHYSICAL SCIENCE COURSES

The stated objectives of these courses, as they appear in the literature, often differ little from those listed for physics and chemistry. Thus we note: (1) an understanding of the basic laws of nature (McLean¹⁴); and (2) use of the scientific method in problem solving (McLean¹⁵). Not so commonly associated with the older courses are the objectives, (3) the solving of problems that arise in daily living in the buying of goods (McLean¹⁶); and (4) acquiring a sense of value of the work of scientists.¹⁷

Still different is the detailed list of objectives related to the needs of the pupil given by Tenney,¹⁸ in which each objective is followed by suggestions for activities suitable for its achievement. It probably does not pay to dwell overlong on the stated objectives of these courses, since a better idea of their nature can be obtained from an examination of their content.

CERTAIN COURSE CHARACTERISTICS

Most of the proponents and planners of these courses think of them as equally suitable as a terminal high-school course in the physical sciences or as

⁹ Physical Science Symposium. "Physical Science Today." *The Science Teacher*, vol. 18, pp. 13-21, 1951 (November).

¹⁰ Lowry, Nelson L. "Biology and Physical Science for Ninth- and Tenth-Grade Students." *Science Education*, vol. 35, pp. 71-73, 1951 (March); Physical Science Symposium, *Op. cit.*; "The Course in Physical Science," *Op. cit.*; Tenney, Asa C. "A Fused Physical-Science Course," pp. 477-500 in *Science in General Education*. Report of the Committee on the Function of Science in General Education. New York: Appleton-Century, 1938.

¹¹ "The Course in Physical Science," *Op. cit.*

¹² Carleton, Robert H. "The Acceptability of Physical Science as a College Entrance Unit." *Science Education*, vol. 30, pp. 127-132, 1946 (April).

¹³ Physical Science Symposium. *Op. cit.*

¹⁴ *Ibid.*

¹⁵ *Ibid.*; Robinson, Myra G. "The Contributions of a Fused Science Course to General Education." *School Review*, vol. 54, p. 215-221; 1946 (April); Tenney, Asa C., *Op. cit.*

¹⁶ Physical Science Symposium. *Op. cit.*

¹⁷ Robinson, Myra G. *Op. cit.*

¹⁸ Tenney, Asa C. *Op. cit.*

the basis for further study. Certain of the courses (e.g., Buell¹⁹), have been planned with the college preparatory group in mind; others (Keirstead and McLean²⁰) for the non-college group.

Of the pupils mentioned in the Biennial Survey,²¹ 6,715 were enrolled in full-year courses and only 291 in half-year courses. A very few such courses, including one developed by the present writer²², have been planned for two years. A common pattern in the schools offering these courses is: eleventh year, physical science; and twelfth year, special courses in physics and chemistry. In some schools, the integrated physical science course may be taken by pupils in either their eleventh or twelfth year.

Some teachers feel that with the increased teaching of science in elementary grades, a ninth-grade general science course may no longer be justified. Thus at Arlington Heights,²³ biology has been moved down into the ninth grade and the physical science sequence is offered in grade ten.

COURSE CONTENT

If it is not already apparent to the reader that a great deal of diversity exists in these various physical science courses, it will become so when we discuss the course outlines given by the various authors. Thus we note that:

1. Some courses are mainly or wholly concerned with physics, and chemistry²⁴ (Guffin,²⁵ 13).
2. Some courses are concerned mainly with physics, chemistry and astronomy (Lowry²⁶).
3. Some courses deal with materials from all five of the physical sciences—physics, chemistry, geology, astronomy, meteorology. Among these we note the course planned by Herriott and Nettels²⁷.
4. A number of the courses²⁸ (Guffin and Lowry²⁹) have an introductory unit dealing with the nature of physical science and methods of work.

But we must do more than list the science disciplines from which the content of these physical science courses has been derived if we are to sense their nature. Let us note a few of the unit titles:

1. Some of these suggest content little different from traditional chemistry and physics. Thus we note: Light (Hogg, Guffin, and Lowry³⁰); Fuels (Keirstead³¹); Chemical Change (Lowry³²).

¹⁹ Physical Science Symposium. *Op. cit.*

²⁰ *Ibid.*

²¹ *Biennial Survey of Education in the United States—1948-1949. Op. cit.*

²² Brown, H. Emmett. *The Development of a Course in the Physical Sciences for the Lincoln School*. New York: Teachers College, Bureau of Publications, 1939.

²³ Lowry, Nelson L. *Op. cit.*

²⁴ Hollinger, John A. and Others. "Physical Science in Senior High Schools." *Science Education*, vol. 28, p. 130-135, 1944 (April); Peterson, Shailer. "The Evaluation of a One-Year Course, the Fusion of Physics and Chemistry, with Other Physical Science Courses." *Science Education*, vol. 29, p. 255-264, 1945 (December); Tenney, Asa C. *Op. cit.*

²⁵ Physical Science Symposium. *Op. cit.*

²⁶ *Ibid.*

²⁷ Herriott, M. E. and Nettels, Charles H. "Functional Physical Science." *Curriculum Journal*, vol. 13, p. 362-365, 1944 (April).

²⁸ Hollinger, John A. and Others. *Op. cit.*; Peterson, Shailer. *Op. cit.*

²⁹ Physical Science Symposium. *Op. cit.*

³⁰ *Ibid.*

³¹ *Ibid.*

³² *Ibid.*

2. Other unit titles suggest the use of science material to answer pupil questions about their daily living. Thus we note such unit titles as: "What Should We Know About Buying Clothes and Household Supplies" (McLean³³); "Conditioning Air for Greater Comfort;"³⁴ "Metals of Importance to Modern Life" (Keirstead³⁵).

3. Not all course makers could refrain from rather vague, though high-sounding phraseology, however, and one author³⁶ suggests that the content should be organized into problems which "illustrate man's quest for basic values."

Space does not permit a listing of all course outlines but the following may be representative:

A. This outline, given by Lowry and his associates,³⁷ suggests a putting together of "chunks" of material from traditional science areas.

1. Introduction (2 weeks)
2. Solar System (3 weeks)
3. States of Matter (2 weeks)
4. Energy (2 weeks)
5. Physics (15 weeks)
 - a. Forces
 - b. Force and Motion
 - c. Work, Energy, and Power
 - d. Sound
 - e. Light
 - f. Electricity
6. Chemistry (12 weeks)
 - a. Chemical Change
 - b. Nature of Chemical Processes
 - c. Solutions
 - d. Non-metals and Compounds
 - e. Organic Chemistry
 - f. Useful Metals

B. This outline³⁸ suggests a considerable degree of reworking of course material, although unit titles are not definite enough to suggest the nature of the course work.

Unit I. Meteorology, Earth Science, and Astronomy.

1. The Weather
2. The Air
3. Water
4. The Earth
5. The Heavens

Unit II. Communication and Transportation.

1. Communication
2. Transportation
3. Fuels

Unit III. Materials and Processes.

1. Metals, Building Materials, and Glass
2. Chemical Products
3. Fabrics

³³ *Ibid.*

³⁴ Hollinger, John A. and Others. *Op. cit.*

³⁵ Physical Science Symposium. *Op. cit.*

³⁶ Robinson, Myra G. *Op. cit.*

³⁷ Physical Science Symposium. *Op. cit.*

³⁸ Herriott, M. E. and Nettels, Charles H. *Op. cit.*

Unit IV. The Home.

1. General
2. Personal

Unit V. Orientation.

1. Men of Science
2. Work and Leisure

C. This outline suggests that the course planners³⁹ have had in mind the functional use of the science content:

1. Introduction.
2. How Can Comfort Be Increased by Air Conditioning?
3. How Does Science Improve Our Homes and Office Buildings?
4. How Does Water Control Our Way of Living?
5. What Should We Look For When Buying an Automobile?
6. How Do We Obtain Our Gasoline?
7. Do We Obtain Food and Poison from the Same Molecules?
8. Will Plastics and the New Synthetic Textiles Make Nations Independent?
9. How Do We Obtain the Most Valuable Metals?
10. What's Wrong with This Picture?
11. What Has Science Done for Communication?
12. What is There Left to Invent and Discover?

Concerning the general problem of integrating their materials not many of the authors have commented. One, however, Hogg⁴⁰ suggests the use of *combustion* as a central theme stating that "It cuts readily across the boundaries. From chemistry it meanders through heat and electricity and into light and electronics. It wanders just as easily into metallurgy, geology, meteorology, and even into astronomy and nuclear energy." One wonders a bit if it is not demanding too much of such a specific and limited idea that it serve as an integrating medium for such diverse and varied phenomena.

An important point, stated by a number of the authors, is that the course outlines are meant to be suggestive, and that they are not necessarily fixed or invariant from year to year. To the writer, it seems that they would have been improved in many cases if authors had been less concerned about covering traditional areas of science and more concerned about developing science units dealing with problems of importance to pupils in their own environment.

CLASS PROCEDURES

The teachers of these physical science courses have used a variety of teaching methods. Motion pictures are widely used. Some have found the use of detailed pupil guide sheets of value (Robinson⁴¹ and Guffin⁴²). A number stress the importance of firsthand experience.

One author, Miles⁴³, selected experiments from books in all areas of the physical science, save astronomy. These experiments were then rated by judges,

³⁹ Peterson, Shailer. *Op. cit.*

⁴⁰ Physical Science Symposium. *Op. cit.*

⁴¹ Robinson, *Op. cit.*

⁴² Physical Science Symposium. *Op. cit.*

⁴³ Miles, Vaden L. "A Determination of Principles and Experiments for an Integrated Course of Physical Science for High School." *Science Education*, vol. 33, p. 147-152 and 198-205, 1949 (March and April).

and Miles was able to draw conclusions with respect to which are most important and the method (demonstration, individual, group) most suitable with each.

The laboratory practice itself varies widely. One teacher, Hogg, has no required laboratory work but uses in its stead a number of required field trips to such places as the local water works, the gas plant, and the rocky section of a nearby beach. Keirstead⁴⁴ has no individual laboratory work of any sort while Buell⁴⁵ has his group engaging in a wide variety of laboratory and other experiences such as a globe study of latitude, longitude, and time; the use of the slide rule; a study of weather maps; and making photographic contact prints. It would seem that laboratory work in these physical science courses should be of a different character from that found in conventional physics and chemistry, but its complete elimination would seem to be most unfortunate. One of the objectives generally held for these courses is that of training the pupil to use and understand the scientific method or the method of critical thinking. Surely they should have some opportunities to solve problems, individually, in a laboratory situation.

Perhaps the most important class procedure mentioned in these course descriptions is that of "pupil planning." Carleton⁴⁶ gives a good description of this method (which he calls a developmental method of teaching) applied to the problem "How do we control fire and burnings." Keirstead,⁴⁷ in speaking of its successful use in his course says that its choice "proved to be a happy one but did not make the role of the instructor any less important." With pupil planning, the instructor may generally (but we would hope not invariably) determine the major areas, or problems, on which the group should work; but pupil planning would be used to determine specific smaller problems to be followed up, the methods of attack upon them, and other aspects of class work.

EVALUATION

Authors generally believe that pupil achievement is excellent in these physical science courses although little supporting data are given. Tenney⁴⁸ states, if a pupil takes his physical science course and both the half-year physics and chemistry courses of the twelfth year, he will have as good a "general background in science as would be obtained from a full year's work in physics and another in chemistry" and that those taking just the eleventh-year physical science course get a "broader concept of physical science than would be received from one year of *either* physics *or* chemistry." Peterson⁴⁹ asserts that the pupils who had one year of his fusion course of chemistry and physics were superior in achievement to those who took physics only, chemistry only, both physics and chemistry, or a course called "Senior Science" only. Peterson's measure was a physi-

⁴⁴ Physical Science Symposium. *Op. cit.*

⁴⁵ *Ibid.*

⁴⁶ "The Course in Physical Science," *Op. cit.*

⁴⁷ Physical Science Symposium. *Op. cit.*

⁴⁸ Tenney, Asa C. *Op. cit.*

⁴⁹ Peterson, Shalier. *Op. cit.*

cal science test prepared by himself. No criticism of any of the developers of these courses is implied in the suggestion that further and more detailed studies should be made of pupil achievement.

The following criteria suggested by Rarick and Read,³⁰ for evaluating a secondary-school science program, might also be used to evaluate these courses:

1. Do the courses offered satisfy the personal-social needs of the pupil?
2. Does the functional information assist the pupil in applying science principles which will be helpful in their lives?
3. Is the scientific method constantly brought to the attention of the pupils as they study scientific principles?
4. Is opportunity given for further exploration in the realm of science?
5. Are scientific principles used in the solution of problems which are challenging, pertinent, and timely?
6. Do the teacher and pupils know what the purpose of the day's work is?
7. Do the pupils know why the subject matter is being considered at that time?
8. Is everything being done to encourage the pupils to further a science hobby, or to work on some science project in which they are interested?

TEXTBOOKS

The problem of finding books suitable for use in such courses is a real one. In preparation for the writing of this article, the author wrote each of the publishers of the four texts mentioned by Carleton.³¹ Two of the three publishers who replied indicated that their books had enjoyed only moderate sale and are not at present in print. The third book is in print, but its actual success was not clearly stated in the letter. Where well-stocked school or public libraries are readily accessible, it may be that a text is unnecessary. But even where many outside books are to be used, there may be values in having a text in the possession of each pupil. When such outside facilities are not available, a text becomes highly desirable, but, as yet, no considerable number of texts are available. Buell³² comments on the difficulties he experienced in using a college physical science text with his classes.

The making of textbooks for physical science courses is not an easy task. Course content is not standardized, nor is it desirable that it should be. Let us not be in a hurry to cast things into a rigid pattern. Also, let us not follow the pattern of making high-school texts which are watered-down versions of their college parallels. A new type of text would seem to be needed.

Perhaps such a text would suggest the content, suitable for use in connection with a rather large number of problems in which young people of today are interested. Some of these problems might interest only those living in rural areas; others, only city dwellers; some would interest all. The text would need to outline the content only sufficiently to define the area of the problem. Then would follow suggestions for work in this area: a few (but not all) of the smaller

³⁰ Rarick, G. L. and Read, John G. "Criteria for Evaluating a Secondary School Science Program." *Educational Administration and Supervision*, vol. 36, p. 306-315; 1950 (May).

³¹ Carleton, Robert H. *Op. cit.*

³² Physical Science Symposium. *Op. cit.*

problems; references to which most pupils would have access; suggestions for the use of community resources, experiments, projects, other activities in which pupils might engage; and lists of several kinds. Such a text might partake more of the nature of a source book than that of a text in the usual sense. Or it may be that a text of quite a different sort is needed. But let us not have merely another conventional text if the book is to be of maximum value to teacher and pupils—and if it is to sell!

SUMMARY

By way of summary, it seems that we can do no better than to cite the "inferences and conclusions" given by the Physical Science Symposium:⁵³

1. The physical sciences are yielding. There is a shift in emphasis from concern for subject matter to concern for the learner.
2. There is no clear-cut pattern for these courses and little evidence of an integrating theme, although there is general agreement on the desirability of integration.
3. The proper role of the textbook is not clear. Possibly an entirely new concept in textbook design is needed.
4. There is uncertainty concerning laboratory work. There is agreement on the desirability of providing the opportunity for individual and group activities. How to adapt the laboratory of conventional chemistry and physics to more functional purposes is the problem. New kinds of laboratory experiences may well be needed.
5. There is general agreement on the use of field trips and for making use of all kinds of resources. The problem is to find the time.
6. Courses have been developed by teachers on their own time, although county and local workshops are being used to help in some places.
7. The teacher is still the "key" figure; some approach the idea with enthusiasm, but some seem overwhelmed by the idea.
8. Present teacher-training programs fail to produce the kind of teacher needed. In-service education is important.
9. Units or areas are generally regarded as resources or guides rather than as inflexible blueprints.
10. Many modern courses in physical science have been approved for college entrance credit.

To these, the writer would like to add:

11. Pupils planning should play a large part in the flexible class procedure suggested in No. 9 above.
12. Integrated physical science courses are probably as well suited as the basis for further college work as are existing special courses.
13. As a terminal course, a physical science course may be superior to special courses.
14. Careful consideration should be given to the contributions of the expanding program of elementary science in planning physical science courses.
15. Studies should be made of the results of instruction in physical science courses, and of claims for these courses such as suggested in numbers 12 and 13 above.

⁵³ *Ibid.*

F. Relations Between Science and Mathematics in the Secondary School

ARTHUR J. HALL

In this article, Dr. Hall argues for a closer integration between high-school science and mathematics, and urges teachers of each subject to tap the resources of the other. The writer examines the nature of mathematics as related to science, discusses psychological considerations in learning mathematics, proposes the creation of a mathematics laboratory, and discusses the possible integration of science and mathematics in the high school. He concludes his article with an analysis of the ways in which secondary-school administrators can encourage this type of development in their systems.

DURING the past two decades, much has been achieved on the educational frontier in eliminating departmental barriers. Today there are offered in the secondary schools many subjects in which arbitrary boundary lines between closely related subjects have been almost completely removed. The greatest gains have probably occurred in correlating social studies and English. The integration of science and mathematics has lagged, and there is a paucity of literature relating to basic experimentation in this area. It is the purpose of this article to explore the relations between science and mathematics and to suggest some ways in which the artificial barrier which too often separates them may be lowered.

THE NATURE OF SCIENCE AND MATHEMATICS

The very nature of science and mathematics makes integration of the subjects natural and favorable. The history of both fields indicates development through the union or combination of the two. Mathematics has assisted in the development of science in three ways. These are:

A. *Mathematics is a means of communicating.* A great portion of our language is qualitative. But when our ideas involve quantity, size, position, or time, we need a different language. This quantitative language is mathematics. In science, many concepts or ideas are neatly packaged by the formula. $K = \frac{1}{2} MV^2$ can be translated into English in several ways, but most precisely to one educated in using mathematics as a means of communicating. One very literal translation would be: kinetic energy is equal to one half the product of the mass and the square of the velocity. Science is replete with the use of the formula and equation to express concepts and relationships.

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B. *Mathematics is a way of thinking.* The formula is also a way of thinking about concepts. Using $K = 1/2 MV^2$, one can think about the relation of mass and velocity to kinetic energy in a convenient and efficient manner. With the same object, say an automobile, one can perceive as the velocity increases from ten miles per hour to twenty miles per hour the kinetic energy increases four times. True, this could be done from the verbal statement but with much greater effort and difficulty. Because mathematical symbols generally possess brevity of expression, precision of meaning, and facility of manipulation, the thinking about kinetic energy as defined by the formula given can be accomplished with a minimum of effort. The uses of mathematics in science and industry seem to indicate that mathematical symbolism simplifies the process of thinking and makes the thinking more reliable.

C. *Mathematics is a means of problem solving.* The sciences have an abundance of quantitative situations that require an answer. Actually in mathematics courses, the pupil gets little if any practice in real problem solving. In most mathematics courses, the "problem" is stated, and just the essential data are given. Real problem solving requires an awareness of the problem and collection of the correct data—much like many science experiments. This kind of experience the science pupil receives, and the typical mathematics pupil does not.

The above brief description of mathematics and its role in science outlines the numerous phases of science that can lend assistance in understanding mathematics and the mutual role of each in re-enforcing the thinking needed in the other.

PSYCHOLOGICAL CONSIDERATIONS IN LEARNING MATHEMATICS

Many science teachers complain that their pupils have not been adequately prepared by the mathematics teachers. In the opinion of numerous educators, the mathematics teachers have just as much reason to say that the science teachers have not prepared their pupils properly. One reason this response has not become familiar is that, to many people, mathematics is only a *tool-subject*. Modern psychology has substantiated the principle that we cannot depend upon transfer but must really teach *for it*. In physics, the pupil may encounter $d = b + vt$ and need to solve for t . Similarly, the same pupil in a mathematics class may be required to solve the equation $x = 4 + 5y$ for y . Can we expect the pupil to see the same process when met in situation quite different in time, space, and sequence? Too often mathematics exercises are carefully tailored so that few if any cumbersome numbers and odd appearing expressions are found in given data and so that answers "come out even." In many cases this makes the exercises quite unlike those found in science.

A PROPOSAL FOR A MATHEMATICS LABORATORY

One of the major reasons that the fundamental aspects of mathematics are not clearly understood by many of our secondary pupils is that the schools do

not provide sufficient experience. From the beginning of formal schooling, verbal symbols replace sensation, seeing, and feeling. Mathematics as it originates in the curriculum is too frequently taught as symbolism without reinforcing by experience. Historically, we have become accustomed to teaching mathematics without a laboratory where some of the badly needed experience in this subject could be acquired. To teach chemistry or physics without a laboratory would seem absurd. It seems as ridiculous in the case of mathematics. Assuredly, symbolism is a very important ability to foster, but this symbolization must be preceded by actual experience so that the symbols have valid and clear-cut meanings.

Most sciences have a laboratory which provides the experience and activity needed for the pupil properly and systematically to progress from the concrete level to the abstract level. Thus, the high-school chemistry pupil not only reads about oxygen but also actually prepares a sample and observes the elementary characteristics of this gas. Throughout most of high-school chemistry, physics, and general science, the provided activity operates at an *object* level before advancing to the abstract, *symbolic* levels. However, the mathematics involved is too infrequently brought to a concrete basis in either the mathematics or science classroom. The transfer of the mathematical concepts, taught on a symbolic basis in the mathematics classroom, to the social and scientific applications is left to the pupil. Unless a definite effort is made to assist him in applying mathematics to science, he will continue to fail to solve equations and formulas which arise in the science classroom even when he has had little trouble in solving the same basic problems in the regular mathematics classroom. The reverse of this statement is equally true.

AN INTEGRATED PROGRAM OF SCIENCE AND MATHEMATICS

In the writer's opinion, curriculum change in both science and mathematics is in order. This change should be in the direction of a much greater integration of the two subjects. The ultimate would have been accomplished in this direction if an observer were to visit, on a particular day, a science classroom (so labeled) and wonder if he had walked into a mathematics classroom by mistake. This observer might likewise visit a mathematics classroom and mistake it for a science classroom. In other words, for each so-called subject to accomplish its purposes, it must borrow more often and more intensively from the other. At the lower secondary levels, this might be illustrated by the following: the pupils in a general science class are studying germination in connection with a unit on plants. Bean seeds are planted and identified by letters. Length of time from planting to the showing of visible shoots is noted and recorded. From these data, the average (mean) time of germination is computed or a frequency distribution made. After the shoot breaks ground, the height of each bean is recorded daily over the period of a week. From these data, a line graph of a particular bean or of the average bean is constructed. This same experiment could

originate in a mathematics classroom just as well. Furthermore, there is a large body of mathematics that must be similarly integrated with the social sciences.

To illustrate this integration of science and mathematics at a higher level, the following is adapted from a high-school physics classroom. A class in physics was studying the functional relationships of the volume of a gas and the pressure exerted on it when the temperature is kept constant. From the data gathered in the experiment and additional quantitative data, graphs were constructed which showed the relationship between the variables and relationships between the absolute and centigrade temperature scales. Next equations were developed from the experimental data as exemplified by graphs just constructed. The equations were seen to express laws first formulated by Boyle and Charles. Finally, came the solution of problems involving p , v , and t through use of the equations derived by the class under the guidance of the teacher. Care was taken to see that the pupils realized that the algebraic equations used were just a convenient way of representing briefly the results of thought and experiment so that the process might be applied without repeating the experiment each time.

THE ROLE OF THE SCHOOL ADMINISTRATOR IN INTEGRATING SCIENCE AND MATHEMATICS

No doubt there is more than one avenue of approach to the integration of science and mathematics in the curriculum. However, to function properly, the plan must be a local solution that effectively utilizes the teachers involved and capitalizes on the local situation and includes industry, business, and school facilities. It is in this situation that the school administrator can pave the way for co-operation, understanding, and support between school and community in making the curriculum functional. It would appear that the school administrator interested in promoting the relations of science and mathematics could facilitate or promote the following: (1) Make available to the mathematics teacher science equipment for learning experiences in the mathematics classroom. (2) Organize committees of science and mathematics teachers to study problems of curriculum, equipment, and co-ordination within the school. (3) Promote in-service seminars that would study the problem. (4) Change the physical aspects of the mathematics classroom so that it would appear more like that of a science classroom. Flat tables such as are found in a biology laboratory and a science demonstration table would be in order. (5) Schedule mathematics and science sections in consecutive hours for groups of pupils. This would permit a double period and would make a science-mathematics integration more possible. (6) Schedule teachers trained in both science and mathematics to teach in both fields and encourage them to experiment along the lines of integration. (7) Protect any teachers who are performing authorized experimental work from unfair critics and keep the public relation lines with parents open. (8) Evaluate both "standard" and experimental programs in terms of the broad objectives of American secondary-school education.

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CHAPTER III

Experience and Experiment— Characteristics of High School Science Teaching

A. The Place of the Experiment in Science Education

FLETCHER G. WATSON

In this article, Professor Watson emphasizes the distinctive role of experimentation in science—how controlled observation renders science different from other fields of knowledge. He then suggests ways in which high-school laboratories can provide true experimentation for pupils, and how what may appear to be a "hopeless" laboratory situation may be converted into one of high educational significance. The article is concluded with suggestions for administrators who wish to promote the improvement of science instruction in their schools.

EXPERIMENTATION, real experimentation, not stylized verification of commonly known reactions or numbers, is the aspect of science which distinguishes it from other creative intellectual endeavors. Historically, modern science did not come into being until the "thought experiment" was extended into *actual* experiment. The thought experiment is exceedingly useful and done by us all every day to check various possible alternate answers against our previous experience, or that of others reported through conversation or writing. Ultimately, however, real problems involve some possibilities which have not been previously explored, at least within the particular set of pertinent conditions. Only through basic assumptions about "how the world ought to be" can the thought experiment assist further in selection among these possible answers. The sterility of the Aristotelean dependence upon a fixed and "correct" world picture emphatically demonstrates the dangers of stopping with some mental projection of what "ought to happen." Beginning in the late sixteenth and early seventeenth centuries, an increasing appeal to actual *testing* of the anticipated reactions, *actual experimentation*, encouraged the flowering of modern experimental and empirical science. Our knowledge of and ideas about the world around us are built on the foundation of experimentation.

This aspect of science has often been slighted in our schools. Because science, like all other areas of human interest, involves a large body of organized information, science has often been considered as merely the same sort of study as the other areas. Actually it has profound differences and only when these are

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explicitly developed in school is the teaching of science justified and profitable as more than an accumulation of potentially useful information.

All youth are expected to develop an extensive body of common knowledge and operating skills. As examples, consider spelling; here innovation and experimentation are not rewarded. Among the manual skills expected is that of writing with sufficient legibility that the writer can communicate with the reader. These examples suggest that part of the school program must involve socially mandated conformity, for, without such conformity, communication becomes impossible.

Oftentimes within the system of mathematics—a great game played according to basic postulates and rules—operations are equated with creative thought in science. This is a grave misunderstanding of both fields. Within the rigorously defined "rules of the game," a mathematician may be justified in writing Q.E.D. at the end of a proof. In science, where the ultimate criterion of success depends not upon internal logical consistency but upon consistency with actual phenomena described only by a modest number of imperfect and selected observations, no such perfection can ever be claimed.

In the social areas, where the problems involve the complex and continually changing interactions of people, experimentation is still severely limited. Generally some action is required and must result from a decision, not an experiment based upon the best knowledge and guesses at hand. The social area is so complex and variable that specific results of particular decisions are difficult to isolate. Because the results of alternate decisions cannot be explored in the non-repetative social complex, such social decisions bear little resemblance to experimentation in the sciences.

In the area of science, considered here more as natural philosophy than as merely organized information, we are able to examine better, through experimentation, into how well our alternative guesses match with actual observations. Here we have an opportunity to reflect consciously upon the process of how man shapes and modifies his personal view of an orderly world out of the multitudinous complex events coming to his senses. This is an epistemological action less available in the other areas mentioned above. In science, where the personal involvement is lower, there is greater opportunity for objective consideration of how we go about reorganizing our experiences and our concepts which unify them. After guided practice, we may reflect upon our operations and suggest tentative but explicit statements of what have been the most effective procedures. Such self-conscious reflection upon what we know, how we know it, and how well we know it is a major goal of all instruction and one most cleanly obtained through science. Especially important is the conclusion that there are observable criteria of consistency and usefulness against which we can check our structuring of experience. Central in this process is the experiment.

This view of science and of experimentation diminishes the importance of the particular subject matter employed while raising to predominance the spirit

of inquiry. Scientific exploration is similar to detective work and to the solution of various forms of word puzzles, but in science the case is never closed or the puzzle completed. For the spirit of inquiry to predominate in the laboratory, there must be real interest, real concern for getting the best possible answer, not just the "right answer." This difference in spirit distinguishes honest experimentation from so much of the routine, repetitive, casual, teacher-set laboratory operation. Little wonder that many school administrators, seeing little or no intellectual capitalization from laboratory periods, have found that money can be saved and problems of scheduling lessened by diminishing or eliminating laboratory sessions. If the spirit of inquiry were restored and even some of the potential goals attained in school laboratories, administrators would (it is hoped) be more sympathetic to their expansion rather than to their deletion.

Perhaps the nature of the present difficulties can be made more explicit by a recent example which is all too typical of many similar experiences. A high-school physics class of "general" pupils had been attempting to determine the latent heat of fusion for water. From numerous publications it was apparent that this value was near 80 calories per gram. After considerable confusion and mild horse-play some results were available. These scattered widely and were obviously unreliable. The so-called experiment was then ended and the teacher commented, in a tired voice, that this was about all you could expect from these pupils. The session was ended and the subject closed, but to the observer, the baby was thrown out with the bath.

Let us suggest what more might have been done with even these wretched results. All science teachers should know that experimentation in the area of heat yields widely discordant figures. Should experimentation in heat, therefore, be avoided because the right answer is rare? Quite the contrary. Here was an opportunity to contrast the difficulties in various fields of isolating the variables and of controlling the experiment. What variations in designing the operation and handling the equipment could have led to more consistent results? No consideration was given to the great care and patience of those who by ingenious procedures have been able to obtain fairly repeatable results. What, if anything, can be determined from widely scattered figures? What an opportunity to introduce some simple concepts of statistics. What an opportunity to inquire into "how well do we know" and the criteria for describing the reliability of information about reactions in the world around us. What an opportunity to contrast these figures with those for the velocity of light where the latest results suggest that for more than a decade we have been using for this vital number a figure probably in error. What an opportunity to examine into the ambiguities that arise when the word "truth" is involved in scientific discussions. What an opportunity to illustrate the tortuous procedures by which man attempts to organize a description of the world and continually reappraise and restructure the description based on previous less extensive information and ideas. Yes, it was a marvelous baby that was thrown out with this bath.

Central in the effectiveness of science instruction, as in all areas, is the teacher. And it is contended here that, for the science teacher, the spirit of inquiry is paramount. While for many, this spirit has not been emphasized in undergraduate collegiate instruction, yet some glimmerings inevitably were present. But in far too many schools the mechanical aspects of teaching and the growing barrage of extracurricular duties drain off the physical energy of the teacher and constantly distract him from serious effort to extend and illuminate what is meant by the spirit of inquiry. In many schools, "good discipline" is valued far higher than any vision of the schools' and teachers' social and intellectual responsibility.

Administrators can greatly help their teachers perform more effectively by encouraging them to be different and to try different materials and methods. Continuous sympathetic inquiry and suggestion, rather than *dicta*, will encourage and reward such growing freedom. Far too many teachers avoid undertaking any innovations by claiming that they are oppressed by College Board examinations, the Regents examinations, "what the colleges require," or some other bogey. Only sensible appraisal of these contentions can lessen their influence, real or imagined.

Other small but important ways in which administration can encourage a superior science program include modest but immediately available ready-cash for perishables and those extras that are needed on short notice. Another indication of interest is a real concern for the availability of journals which will stimulate the teachers by supplying information, ideas, and perspective. Active interest is needed in improving the working space allocated science which, through neglect and a "nobody-cares" attitude, can become a dreary place cluttered with discarded and dust-covered equipment. Every administrator knows that the science budget is rarely considered to be enough, but wise council and stimulating suggestions may reveal that the available equipment is sufficient or that sizable investment in capital equipment is actually needed.

More thoughtful discussion of possible teaching programs, all too often passed out as "assignments," will result in better utilization of special skills and knowledge and, more important than these, enthusiastic and stimulating instruction.

Administrative support for, but a hands-off policy on the direction of, teachers organizations may provide means for teachers to interchange ideas, report results, and explore the instructional potentialities of other materials. Such critical intellectual exchange is severely needed throughout most of the country. Hundreds of teachers are withering on the vine for lack of contacts which emphasize and sharpen the spirit of scientific inquiry.

Inevitably salaries will be lower than proper and far too many teachers must resort to after-school and Saturday jobs to supplement their incomes. No pronouncements here are going to alter the grim facts, yet it is possible that the

sort of teaching discussed, in which real experimentation is the core, will result in greater public respect and ultimately in increased remuneration.

Throughout the literature are pleas for making instruction "functional" and for implanting "the scientific method." These are but vague labels for certain operating abilities which we hold to be desirable. The actualities of scientific investigation are not going to become significant to pupils through the chanting of incantations or filling in any five-step laboratory report forms. Only direct experience with the factors, preferably even unnamed, involved in creating some tentative order in the complex world will provide the pupils with an internal awareness of what science is like. At the core of such efforts to create some understanding of scientific inquiry is the most important invention of the past four hundred years—experimentation.

B. Learning in the Laboratory

ROBERT STOLLBERG

In this article, Dr. Stollberg explores the role of the laboratory in secondary-school science education, pointing out why laboratory education is due for a thorough re-examination and suggesting objectives for laboratory learning. Next he discusses fifteen features which he feels characterize desirable modern laboratory procedures. He concludes the article with a list of specific ways in which high-school administrators can promote improved learning in the science laboratories of their schools.

AS in most educational endeavors, there is no *one best way* to organizing learning in the laboratory—no "royal road" to success. Rather, there are many effective patterns of laboratory experience for high-school pupils. It is the purpose of this article to suggest to administrators and teachers several approaches to this important aspect of science education. Some of the approaches are well established, others are relatively new innovations—often controversial in character. The presentation will take the form of a discussion of characteristics of good learning situations in high-school science laboratories. As a background for these comments, it is useful to examine the proper role of the high-school laboratory in modern science education.

THE ROLE OF THE HIGH-SCHOOL SCIENCE LABORATORY NEEDS RE-EXAMINATION

A consideration of the proper place of the high-school science laboratory is particularly timely at the present stage of educational development. During most of the last half-century, the value of laboratory learning has been seriously

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challenged. The broadening population base of the public schools has yielded classes which are not nearly so highly selected as those of previous generations. With this has come the fact—often slowly realized—that only a minority of high-school pupils are preparing for college and, of these, only a very few will actually major in science. And as the college preparatory function of high-school science becomes less and less dominant, it is all too easy to infer that the science laboratory should accordingly minimize. Then too, increasing enrollments, expanding curriculums, and rising school costs have placed the laboratory in a defensive position, for there is no doubt that science laboratories are expensive in terms of time and space as well as in terms of money. The classroom demonstration has come into its own.¹ Unfortunately, many educators regard learning through demonstrations as a *substitute* for laboratory learning, rather than viewing these two learning situations as *complementary* to each other and to classroom work in general.

A modern view among science educators² is that both the laboratory experience and the classroom demonstration have their rightful place in the high-school science program. A considerable body of research³ has failed to reveal that either teaching technique is so inferior to the other as to justify abandoning it. In cases where laboratory learning has appeared fruitless, one might agree with Franzen⁴ who pleads that laboratory ineffectiveness is due not to inherent weaknesses in this form of pedagogy, but to unimaginative, uninspired, and generally unsound patterns of laboratory administration. Many science educators urge that high-school laboratory procedures be re-examined and re-structured in terms of the changing character of secondary-school science education.

Continued emphasis on general education provides a constant reminder of the old but worthy maxim that "we learn by doing." Science learning in the laboratory, when properly carried on, is a high order of "learning by doing," and we find that modern educational psychology thus strongly supports the laboratory as a tool of science education.⁵ Again, modern educational doctrine places heavy emphasis on the importance of problem-solving ability as a goal of education.⁶ This too supplies a solid foundation for the high-school science laboratory, particularly when it is centered about problem-solving situations. In this connection, it is interesting to note that many other subject areas are adopting the laboratory as a means of instruction. Accordingly, speech laboratories, remedial reading rooms, and mathematics laboratories⁷ are taking their

¹ National Society for the Study of Education, Forty-Sixth Yearbook, Part I, *Science Education in American Schools*, Chicago: Univ. of Chicago Press, 1947, pp 236-8.

² *Ibid.*—pp 53-4.

³ *Ibid.*—*loc. cit.* Also see: Cunningham, "Lecture Demonstration versus Individual Laboratory Method in Science Teaching, a Summary", *Science Education*, March 1946, pp 70-82. This analysis surveys 37 studies which compare or evaluate laboratory and/or demonstration teaching procedures.

⁴ Franzen, "The Place of the Laboratory in the Teaching of Science", *School Science and Mathematics*, Dec. 1951, pp 708-13.

⁵ Sutton "Laboratory Work is Essential", *School Science and Mathematics*, May, 1949—pp 151-8.

⁶ National Society for the Study of Education *Op. cit.*, pp 28-35, 51-2, 235-6.

⁷ See Hall's article in this publication.

places beside the more familiar home economics kitchens, industrial arts shops, and science laboratories as parts of the pedagogical process.

THE OBJECTIVES OF INSTRUCTION IN THE SCIENCE LABORATORY

What, then, is the role of the high-school science laboratory? Do its values justify its expenses? In what unique ways can the laboratory contribute toward the objectives of science education and toward those of education in general?

The role of the laboratory in science learning cannot be considered separately from the objectives of science education as a whole. These have been discussed in other sections of this publication. There are, of course, certain functions of science education which can be implemented in a science laboratory as well as or better than through any other learning activity. These invaluable, though not always unique, functions of the high-school science laboratory are suggested below:

1. As a result of experiences in the science laboratory, pupils can become increasingly adept at critical thinking. This is true because the laboratory can offer innumerable opportunities for genuine problem solving. This includes experience in all the kinds of behaviors involved in scientific thinking; such as,

- a. sensing, identifying, and isolating problems
- b. locating and organizing useful information
- c. setting up tentative solutions to problems
- d. testing, modifying, and retesting tentative solutions.

2. As a result of experiences in the science laboratory, pupils can become increasingly proficient in their powers of *observation*, as contrasted with mere *looking* or *seeing*. Well-conducted laboratory experiences involve observation which is strategic and purposeful, planned and organized, deliberate and meticulous. This is a variety of behavior which is of great value both in and out of the science laboratory.

3. As a result of experiences in the science laboratory, pupils can develop the keenness of their initiative, the versatility of their resourcefulness, and the effectiveness of their co-operation. Well-selected and guided laboratory experiences demand inventiveness and originality on the part of the pupil, and co-operative enterprise is a "must" in a laboratory shared by many pupils, whether they be working on individual projects or in small laboratory groups. Like the attributes listed in "2" above, these are much to be desired in all people at all stages of life, regardless of whether or not they are engaged in laboratory type work.

4. As a result of experiences in the science laboratory, pupils can gain deeper insight into the work of the scientist and the role of the laboratory in mankind's progress. Modern schools provide pupils with learning-by-doing opportunities to become acquainted with the press, with government, with politics, and with entertainment. In an age when science is so vital to human welfare, it is impor-

tant that young people also understand the role of science and scientists in the structure of civilization.⁸

5. As a result of experiences in the science laboratory, pupils can acquire an improved understanding of basic concepts, principles, and facts of science.⁹ Science teaching confined to the classroom is likely to depend chiefly on verbalization and pictorial representation as a means of communicating ideas. To this the science laboratory can add the important experiences of *contact*, both observational and manipulative, *with actual equipment and processes*.

6. As a result of experiences in the science laboratory, pupils can increase their proficiency in *generally useful* skills. Many skills which are valuable in daily living can be improved in the science laboratory. These include recording, organizing, and analyzing information, making readings on various kinds of measuring instruments, and handling and storing of delicate equipment. There are, of course, many other skills useful to the prospective technical pupil, but the emphasis here is on skills of value to the general pupil and future citizen.

7. As a result of experiences in the science laboratory, pupils can develop interest in and curiosity about principles and processes related to science. While this largely represents *avenues to science learning* rather than science learning *per se*, it, nevertheless, constitutes an important role of the laboratory in high-school science education.

SOME CHARACTERISTICS OF GOOD HIGH-SCHOOL SCIENCE LABORATORY EXPERIENCES

Throughout the foregoing analysis of the function of the high-school science laboratory, there has been a deliberate use of the words, "As a result of experiences in the science laboratory, pupils *can* . . ." This phraseology is intended to enforce the notion that these desirable features are by no means "automatic and guaranteed" outcomes of learning in the laboratory. Indeed, in many mis-handled high-school science laboratories, pupils learn-by-doing to work carelessly and without planning, to cheat and to "juggle the facts," and to scorn and ridicule the painstaking work of a real scientist. There may be high-school science laboratories where such undesirable learning outweigh the desirable outcomes; in such cases, it is highly proper that the laboratory phase of the science program be radically changed—or completely eliminated.

The statements which follow are neither "rules" nor "step-by-step" procedures for operating a science laboratory. Rather, they might be called "hallmarks of good laboratory education in high-school science". Each recommendation should be accompanied by the qualification, "Other things being equal . . ." In general, the obvious, routine patterns of laboratory learning have been omitted from this list. Such procedures as "having suitable time and space", and "providing pupil preparation and follow-up", *etc.* have been skipped on the

⁸ Bernal, "Science Teaching in General Education"—*Science Education*, Dec., 1945, pp 233-40. Makes an unusually strong plea for this particular objective of science education.

⁹ Sutton—*Op. cit.*

grounds that they are self-evident, and also that they are generally accepted by science teachers. In contrast, the patterns listed below are often experimental and are frequently the subject of heated discussions among science educators. But they are, in the opinions of many, highly worth-while characteristics of learning in the laboratory.

1. *Classroom and laboratory work* should be closely integrated. However, there seems to be no set rule as to which should precede the other. On some occasions, classroom discussion may well prepare the pupil for laboratory experience; on others, problem situations encountered in the laboratory profitably lead to spirited and productive classroom discussions. In any event, classroom and laboratory experience should not be divorced to the extent that they appear as "separate courses," or that pupils can profitably take one without the other. Each type of learning should support the other, knit together with other types of activities to constitute an integrated set of learning experiences.

2. *Flexibility* of the laboratory schedule is highly desirable. Rigidly scheduled periods for laboratory experiences make it difficult to integrate classroom and laboratory learning and to attack in the laboratory problems which spontaneously arise in the classroom. From this point of view, the modern trend toward 50- or 55-minute periods—one each day—offers some distinct advantages over the older system of having two days per week scheduled as laboratory period of twice-normal length.¹⁰ Of course, if this advantage is to be exploited, the science teacher must have access to the laboratory at any time. This may be done either by having an available laboratory adjacent to the classroom or, better yet,¹¹ by providing combination classroom laboratories, which can be used for any in-school function at the will of the teacher and pupils.

3. *Seeking answers and finding information* is a proper function of a laboratory. There are many instances, of course, where a worth-while laboratory experience can be organized on the basis of *demonstrating*—i.e., seldom actually *proving*—some natural law or some physical constant. It is also true that much of science has not yet reached the stage of dependable measurements, and there is justification for using laboratory experiences for *observing* the behavior or structure of some natural organism or man-made device. However, this does not preclude problem-solving in the laboratory. Whether laboratory experiences be centered around measurement, demonstration, or observation, the bulk of laboratory learning should be devoted to seeking answers to problems and finding information which is desired.¹²

4. *Real problems* are most desirable for laboratory learning. While sample classic problems have some place in the high-school laboratory, they are in general inferior as a basis for laboratory activity to the problems that arise from class discussion, from pupils' personal living, and from the school and com-

¹⁰ Franzen, *Op. cit.* See also National Society for the Study of Education, *Op. cit.*, p. 44.

¹¹ *Ibid.*, p. 57.

¹² Franzen, *Op. cit.* See also National Society for the Study of Education, *Op. cit.*, pp. 51-2.

munity.¹³ Problems such as "How does the water pressure in *this* community vary from day to day?" "Is the lighting adequate in *this* laboratory?" "Is *our* basketball team getting adequate nutrition and rest?" and "What would happen if we bubble pure oxygen into *our* aquarium?" are examples of real problems which can be approached in the "laboratory" (see item 9 below). Some of the problems may have no known answer at all, while others may be problems to which the answer is known, but not to the pupils.

5. *Practical applications* should be a part of laboratory learning wherever possible. When classic or theoretical situations are used as a basis for laboratory experience, they should be applied to real-life situations. The coefficient of thermal expansion can be illustrated in the form of a bimetallic thermometer or expansion joints in a bridge or a roadway; "buffer action" can be illustrated in the form of headache tablets, photographic chemical solutions, etc.; the principle of diffusion can be applied to water absorption by roots, soaking of dried fruits, and nourishment of cells. In general, a scientific principle is of value only because it explains, clarifies, or predicts some real-life process, behavior, or device. When the practical example is shorn from a principle, the very reason for including the principle in the learning experience is largely removed.

6. *Co-operative planning* by pupils and teacher is desirable as a part of laboratory learning. Guided discussions can serve to identify the problem and to set up patterns of solving it. This presupposes that the laboratory experience has not been "lifted" from a typical laboratory manual (see item 8 below). This gives pupils opportunities for setting up problem situations in a form in which they can be attacked, and in thinking through methods of attacking them in the laboratory. Many such laboratory situations have been described in the literature.¹⁴

7. *Improvization of apparatus* by pupils is a valuable phase of laboratory learning. When pupils plan their own procedures, they may be obliged to set up their own experimental materials with such item of apparatus as are on hand in the school and the home. Some equipment may have to be constructed; other may be adapted or improvised from supplies common around the laboratory. In many cases, laboratory experiences will have to be modified in terms of available materials. All this provides real opportunities to develop resourcefulness, ingenuity, and construction skills. While pupils are providing and setting up their own equipment, they often encounter unpredicted problems which must be solved before they can go on. These are problems of the most genuine character—they are not imposed by the teacher—they must be recognized and solved largely by the pupil himself. These sorts of emerging problems provide

¹³ Forbes, "Purpose in Laboratory Experiments," *Teachers College Record*, March 1948—pp 423-6. Discusses this point in considerable detail.

¹⁴ Herrick, "Koch's Postulates as a Simple Laboratory Exercise in Biology," *Science Education*, Feb., 1948, pp 34-7; Hellman, "A Laboratory Method for High School Physics," *The Science Teacher*, Dec., 1947, p 165 et. seq.; Lefter, "The Teaching of Laboratory Work in High School Physics," *School Science and Mathematics*, June 1947, pp 531-8; and Ruchlis, "A Laboratory Experiment in Ohm's Law Adapted to the Teaching of Scientific Method," *School Science and Mathematics*, March, 1947, pp 222-4.

the most excellent sort of experience in practical problem solving. The inevitable occurrence of these situations constitutes one of the great strengths of the pattern of laboratory (and other) learning often known as the project method.¹⁵

8. *The use of the laboratory manual* may well be confined to its value as a reference. Most of the items in this discussion assume that the laboratory manual is NOT the basis for the organization of the science laboratory, but is rather an AID. Pupils seeking to establish their own laboratory procedures may consult a variety of such manuals for suggestions and for data, yet not follow any one of them "cookbook" style. In using such manuals, it is well for the teacher to remember that, almost by definition, they are written for use by the *average* teacher, with *average* background, ideas, inspiration, and equipment. A *better-than-average* teacher may profit by heeding Lewis¹⁶ who advises that typical, orthodox laboratory manual writeups may almost arbitrarily be assumed to be poor.¹⁷

9. *The boundaries of the science laboratory* should be considered as the actual boundaries of the pupil's experience. That is, the laboratory should be thought of as an *approach*, as a *method*—not merely as a place. Many laboratory experiences can be at least partially carried out in the hall, in the school yard, in an automobile, at home, or elsewhere in the community. The library, the field trip, and the information-seeking letter, and the interview are also desirable avenues for acquiring information. The laboratory "room" should be considered merely as a *headquarters* for laboratory learning.¹⁸

10. *Long-term laboratory activities* are to be encouraged. This is true of all sciences, but particularly so in life sciences where many processes are by nature comparatively time consuming. In general, this means that fewer "experiences" are undergone, but that each occupies more time. It is by no means necessary that all pupils perform the same laboratory learning activities. Permitting individuals or small groups to carry out laboratory activity in which they are most interested and for which their talents are best suited constitutes an excellent means of meeting individual differences among pupils.¹⁹

11. *Note taking, data recording, and sketching* should be truly functional. Pupils should not be required to perform these laboratory tasks merely for their own (the tasks') sake. Rather, notes should be taken when pupils actually need them, data should be recorded when recording helps clarify them, or when they are needed for future reference, and sketches should be made when they are actually needed, and when they are not already available. There are so many

¹⁵ Herrick, *Op. cit.*; Lefler, *Op. cit.* Both these articles bring out the existence and value of these "emerging problem-solving situations."

¹⁶ Lewis, "How to Write Laboratory Studies which Will Teach the Scientific Method," *Science Education*, Feb., 1947, pp 14-7.

¹⁷ Richardson and Cahoon, *Methods and Materials for Teaching General and Physical Science*, New York: McGraw-Hill, 1951, pp 29-32. Discusses this point at greater length.

¹⁸ Laton and Powers, *New Directions in Science Teaching*, New York: McGraw-Hill, 1949. Through the book many examples of new departures in science education suggest laboratory experiences performed outside school property.

¹⁹ Lefler, *Op. cit.* Discusses this item in greater detail.

occasions when these laboratory habits *must* be cultivated in the process of problem-solving that it is needless to enforce them on pupils arbitrarily. That is, these tasks should be means to ends, not ends in themselves.

12. *Reports of laboratory activities* should have purpose and meaning. The purpose of a report of a laboratory (or any other) experience is either for communication to other people or for future study and reference by the performer. This does not include writing a report for the teacher to see if the pupil really understands his work. It is doubtful if the educational value *per se* of writing a laboratory report is equivalent to the actual laboratory experience which the report writing usually displaces. An ideal way to make the report functional is to permit one pupil (or group) to describe his activities to the remainder of the class, who presumably have been occupied with other activities. The report may be oral, written, dramatic, demonstrational, graphic, photographic, or in any one of a number of other forms of modern communication techniques. Few of the printed laboratory manuals provide any opportunity for reports of this meaningful nature.

The comments above are intended to apply to all high-school science laboratories—physics, chemistry, biology, general science, and others. The following items are aimed specifically at the life sciences:

13. *Live materials* are a desirable medium for biological science laboratory experiences. As Patterson²⁰ indicates, it is a travesty on meaning that biology is the study of *life*, while most of the laboratory work is done with *dead* materials. Of course, some experiences in the biology laboratory will continue to be carried on with preserved and mounted specimens, but teachers should include as much living materials in their pupil activities as possible. Caged animals, insect colonies, bacterial cultures, yeast cultures, incubating eggs, gardens and farms, controlled growth of plants, aquariums and terrariums, and—above all—human beings (often in the form of the pupils themselves) provide examples of the breadth of possibilities with living experimental materials.²¹

14. *Problem solving* is desirable in life science laboratories, too. Altogether too many life science laboratories confine their activities to almost casual observation of living phenomena or preserved specimens, and to a study of the structure of organisms. To a limited degree, such activities may be perfectly proper, but they should not be permitted to dominate the high-school biology or any other science laboratory. Teachers of life science—like those in other fields of science—should strive to set up their laboratory learning in such a way as to center it around real problems in the field.

15. *Diagramming and sketching* of experimental materials should be examined with great caution. Many life science laboratories stress these activities to excess. Diagramming and sketching should be confined to those instances where the pupil actually needs the diagram or sketch (see item 11 above), not to those

²⁰ Patterson, "Do We Teach Biology?" *School Science and Mathematics*, March, 1949, pp 248-50.

²¹ Laton and Powers, *Op. cit.*, pp 72-8. Describes several kinds of laboratory experiences involving the study of human processes.

where the teacher requires it to make certain that the pupils are kept busy. There is considerable research to show that emphasis on exact representation and artistic skill in drawings bears no fruit in terms of pupil understanding. The practice of having pupils trace drawings from books or manuals is of even less value.²²

These, then, are some of the characteristics of good high-school science laboratory experiences. No one science teacher—no one school—need display all these features in the organization of laboratory learning. Nor, on the other hand, is the pursuit of any—or all—of these a guarantee of truly effective laboratory education. In many actual situations, it is difficult to try to make progress along more than a few of these lines at one time.

THE HIGH-SCHOOL ADMINISTRATOR CO-OPERATES

In school systems which desire to improve their laboratory procedures along lines such as those suggested on these pages, the science teacher is faced with a tremendous task. But the science teacher cannot do it alone. Without sincere encouragement and energetic co-operation from his school administrators, the teacher is all but helpless. Some of the ways in which principals and superintendents can promote this more effective brand of learning in the laboratory are listed below:

a. Encourage science teachers to explore new patterns of science teaching. Give recognition to their efforts and be patient with their false moves.

b. Give science teachers *full credit* for laboratory teaching. It is not fair to discount their laboratory instruction time 1.5 to 1 or 2 to 1 and still expect great things from laboratory learning. There is no reason to suppose that an hour of laboratory teaching is less work—or less effective with pupils—than an hour of "classroom" teaching.

c. Permit science teachers time to visit other forward-looking science teachers—particularly in other schools. A little of this "cross-breeding" of ideas often produces amazing results.

d. Where possible, set up class schedules so as to facilitate laboratory-classroom flexibility. This means *not* forcing the science teacher to conduct laboratory during certain periods, classroom activity during others.

e. Schedule reasonably small numbers of pupils in laboratory classes. Based on the wide-spread recommendation of a maximum of twenty-five pupils in any high-school class, twenty would make a good maximum for an effective laboratory class size.

f. Where possible, schedule science teachers for several periods in the same room, rather than giving them "one-period stands" in one room after another. It is impossible to do effective science teaching in an un-equipped room where advance preparation cannot be made.

²² National Society for the Study of Education, *Op. cit.*, pp 55-6.

g. Do away with screwed-down desks in science rooms (and many other rooms). Movable tables and chairs are much more conducive to a variety of experiences in science. Indeed, such a room, with a few sinks with running water, some gas outlets, and some electrical outlets can permit a surprisingly large variety of laboratory work, particularly in general science.

h. Permit the science teacher to have a considerable variety of library resources in his laboratory classroom. Many of these he will provide himself, particularly in the form of free materials from business, industry, and government; others may be had on long-term loan from the school or local public library. Provide periodicals in science and science education—as well as numerous reference and collateral reading books in science—from school funds. Science students should be permitted access to the school library during the period of their science class or laboratory.

i. Permit the science teacher to have at least limited workshop facilities in his classroom laboratory. A bench vise, a few hand tools, and some inexpensive construction materials are conducive to effective laboratory experience.

j. Provide ample storage facilities for science equipment. Many economies in equipment and opportunities in learning can be effected when seldom-used or bulky materials can be stored for future reference.

k. Provide an ample budget for science equipment and materials. It need not be extravagant. Many of the characteristics of good laboratory procedure outlined on previous pages can be carried out at considerably less expense than can the more traditional sorts of laboratory experience.

l. Provide an ample petty cash fund for science expenditures. Many highly useful items cannot be obtained in advance; often their need is not anticipated more than a few days before they are to be used. There is no reason to penalize the ambitious science teacher by obliging him to make all his purchases many months in advance.

m. Permit wide use of the school both during and after school hours. Pupils should be permitted to use various portions of the school property—auditorium, boiler room, gymnasium, school yard—for their science experiences. Often these activities will extend beyond normal school hours; in this case pupils should be permitted access to school property *under supervision*, and the science teacher should be given complete freedom to function within the school at any time of the day or night, including weekends and holidays.

n. Permit science pupils *under adequate supervision* to exploit community resources during school hours. This may mean occasional skipping or doubling up of classes, but at least a few such field trips during school hours are well worth the inconvenience they may entail.

o. Permit school equipment to be taken from the school within the framework of an adequate check-out system. There are many valuable science experiences which can be provided if pupils can check out the necessary materials for home use.

p. Continuously evaluate both traditional and experimental science teaching methods. This evaluation should not be in terms of "the number of experiments completed," "the beauty of the laboratory reports", or "the formal decorum of the science laboratory." Rather, it should be in terms of the broad objectives of laboratory learning, of science education, and of American secondary schools.

Many of these recommendations—like those characteristics of good high-school science laboratory experiences previously listed—are highly controversial; others are relatively new departures. Most of them are difficult to put into practice. At their worst and at their best, however, these suggestions do represent desirable directions for change for those administrators and teachers who desire that the boys and girls in their charge shall get the most out of their learning in the laboratory.

C. Modern Science Rooms and Laboratories

GUY P. CAHOON

JOHN S. RICHARDSON

In this article Professors Cahoon and Richardson discuss many factors which should be kept in mind when designing, equipping, or renovating science classrooms and laboratories. Based on the premises that science rooms should be flexible and should provide for a wide variety of learning experience, the writers' recommendation is for serious consideration of multi-purpose rooms, not only serving for classroom and laboratory activities, but also, in many cases, serving multiple science courses. Among the factors discussed are relation of science rooms to those of other subject areas, appearance of science rooms, provisions for audio-visual activities, storage facilities, recent trends in science furniture, utilities needed in science rooms, and provision for use of the resources of the school and community. Throughout the discussion, frequent references are made to the significant economies which can be effected while upgrading the quality of science rooms and laboratories.

CONSIDERATION of the space used for the teaching of science is necessarily based upon the philosophy underlying the anticipated teaching. As we consider the place of science in the life of the individual today, we must recognize that the impact of science and technology upon our very existence is ever increasing. The time has long since passed that the school can afford to act as if science is only for the specialist. Present-day problems of living require that every person who is to be effective and to operate intelligently in our society must have some knowledge of science and must know much of its application.

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One of the major needs of our lives today is the characteristic use of the scientific method in our approach to the problems of living. It has long since been demonstrated that we cannot approach the solution of problems as an objective of learning if problems do not exist as a part of the learning process. This has quite clear implications for the nature of the space provided for learning.

The curriculum of present-day schools, so far as science is concerned, is moving slowly, but definitely, away from the emphasis on a few fixed courses which are of college preparatory nature. Instead, science is inextricably interwoven with all phases of the curriculum. This process begins in the elementary school and continues through the junior and senior high school. Science becomes a part of the curriculum in mathematics, in social studies, and in English. It has, as well, its interrelations with business, industrial arts, agriculture, home economics, and foreign languages. In many schools, this integration is only beginning. In other schools, the place of science in the core curriculum is well established.

The pattern of science courses in most high schools provides for general science in the junior high school, and biology, chemistry, and physics in the senior high school. Many variations are found, including physical science in the senior high school as well as aeronautics, conservation, practical electricity, and photography. Whatever the offerings may be, there is an increasing use of project-type experiences and provision for individual investigation involving in many cases the use of improvised apparatus. The class procedures involve an increasing use of large and small group discussion.

Regardless of the type of curricular organization, there is general agreement that the science program for today's secondary school must include a broad range of experiences, thus to provide for the broad range of abilities and needs that we find in the school population. The provision of such experiences depends upon many kinds of activities—activities which are challenging to young people of varied backgrounds. However, such a broad range of experience is possible only if there is sufficient space and if it is so planned that it can be used in a variety of ways. The planning of space for science teaching, the provision of facilities of various kinds, and the interrelationships of the science areas and other areas in school deserve the utmost care so that the program which the secondary school provides will be both rich and effective.

FLEXIBILITY OF SCIENCE ROOMS

The need for a broad range of experiences and for ready change from one type of activity to another is showing ever more clearly the need of a multi-purpose science room. Such a room is planned, in general, to provide not only for all the science activities of a given course, such as physics, but also for a variety of courses. In many schools the multi-purpose science room provides for a major part of the indoor activities of all the science classes. There are no separate rooms for class and for laboratory work. While such a room may not be satisfactory for all schools, it provides, for most schools, a desirable flexibility of room usage

for various science courses as well as the resources essential to a breadth of experience. In larger schools, it is often necessary to provide more than one science room, and in such schools two or more multi-purpose science rooms are planned.

The multi-purpose science room is characterized by a relative freedom of fixed structures even though the use of such utilities as gas, running water, and electricity requires that certain kinds of work space be fixed. With careful planning, flexibility can be achieved without the loss of essential utilities. There is a definite trend toward the arrangement of the room for the teaching of science with the utilities placed along the walls of the room rather than in the central portion of the room. Thus it is possible to use the central space for tables and chairs for class purposes, for the use of large or small discussion groups, and for other kinds of activity. In addition, it makes it possible to bring into the room those kinds of apparatus that require relatively large area for study and experimentation. Fortunately, it has become evident that it is less expensive to provide science facilities in such a room than has been true in the past when separate rooms have been provided for laboratory and class purposes. The latter arrangement has generally resulted in an unused laboratory while the classroom was in use, and *vice versa*.

Flexibility is increased also through the use of accessory rooms. There is an increasing use of small rooms adjacent to the multi-purpose science room. Such rooms are used for storage, for preparation of materials, for project work, and for the teacher's own use in conference, record keeping, and the like.

SPACE NEEDED FOR SCIENCE TEACHING

With the increasing range of essential learning activities in science, an increasing amount of space per pupil is necessary. If rooms are so planned that most learning activities, including class work and laboratory experimentation, are held within the room, the per-pupil area should be from thirty-five to forty square feet. This does not include such accessory rooms as those for storage, preparation, photography, project work, or others. If accessory rooms are included in the calculation, the area provided for each pupil should be fifty square feet. The apparent increase in the area per pupil can be accomplished often through the use of multi-purpose science rooms, thus eliminating the vacant classroom or laboratory while one or the other is in use.

The planning of science facilities should make specific provision for out-of-door science facilities. The school grounds should provide plots for growing plants and opportunities to study animal life. Nearby community facilities should be available to and used by the school in the many avenues of the study of science.

ORIENTATION OF SCIENCE ROOMS

The developments in the teaching of science today are placing ever more emphasis on the orientation of science rooms with reference to other parts of

the building and with reference to the use of the rooms so far as the teaching of science is concerned. While there is no apparent consensus as to the direction which the science room should face, there is general agreement that the science room or rooms should be relatively close to other related areas. Of course, these related areas can extend throughout the school. However, there is much in common between science and the areas of industrial arts, home economics, and agriculture. In some instances, it is possible to provide one or more rooms that serve both science and a related area. An example of such a room is a darkroom, which may be used not only for science, but also for industrial arts and the photographic work in connection with the school newspaper and yearbook.

There is a very significant advantage in locating the science rooms on the first floor of the school building. In general, this location makes readier access to the out-of-doors. From a financial standpoint, it is also advantageous in that the necessity of extended plumbing and other service lines is reduced.

ATTRACTIVENESS

There is much need of attention to the attractiveness of science rooms. While efforts have been made to provide clean and neat appearing furniture and furnishings, in general the very nature of science facilities has tended to make the rooms unattractive. The necessity of fixed furniture in itself gives an undesirable quality of inflexibility and formality. The design of science rooms should be such that the rooms are pleasant as well as flexible. The decoration of the rooms should prove inviting to pupils rather than repulsive, as many drab and dirty rooms are. The rooms can be so illuminated that they are pleasant places in which to work. Ventilation of the room provides for freedom from odors which are obnoxious and repulsive to many pupils. The surfaces of desks can now be produced in bright and attractive colors and still retain the needed durability of such working spaces. It is possible to provide chalkboards and tackboards in lighter and more attractive colors than many that have been used in the past. With planning, attractive rooms need be no more expensive than rooms that are unattractive and even repulsive to pupils.

PROVISIONS FOR AUDIO-VISUAL FACILITIES

The teaching of science requires that there be ready access to audio-visual facilities of a wide variety. Science depends upon a wealth of experience; audio-visual resources make an important contribution to this experience. In planning the room, outlets are needed at various convenient points for 110-v. a.c. to supply power for projectors. There should be provisions for adequate darkening of the science rooms for projection.

There should be an adequate amount of display space. Exhibit cases and shelves should be provided. Well-lighted areas of chalkboard and tackboard are needed; the minimum size of each is approximately fifty square feet. Display rail is used to supplement tackboard space in many schools.

STORAGE FOR SCIENCE ROOMS

The storage of the resources for the teaching of science can be provided profitably in two different ways. It is advantageous to have much of the storage for science work within the classroom laboratory or multi-purpose room itself. This kind of storage provides ready accessibility to the equipment and materials that the pupils need. It has the effect of preventing bottlenecks in the use of a single storeroom for all resources.

There are definite advantages in a second type of provision—a separate room for storage and preparation. Within such a separate storeroom can be placed those materials that are to be used by other science classes and those that will be used in individual laboratory or project work. This is particularly advantageous if a separate room is available for individual pupil work. There should be storage space in such a separate room. In the usual school, it seems advisable to provide storage of both types. Such an arrangement encourages a good teaching situation and is probably no more expensive than the centralization of the storage in one room.

FURNITURE FOR SCIENCE ROOMS

Recent years have seen the development of several new types of laboratory furniture. In general, these types provide for multiple use of the various tables and desks. This development of furniture is in accordance with the plan of providing a science room to serve several sciences, to serve all the activities of a given field of science, or a given class. Recently developed furniture provides for freeing the center of the room for various purposes. The design of this furniture does not limit the amount or the kinds of use to be made of it.

The school administrator who is faced with budgetary problems may profitably examine simplified furniture. There has been a tendency in the past to provide furniture that is much more expensive than necessary. An example of this is in the demonstration desk at the front of the room. Demonstration facilities are, of course, essential to good science teaching. These facilities require that such utilities as running water, gas, and electricity be available. However, it is not necessary to construct an extremely large desk or table to accommodate such utilities. Essential as a demonstration desk is, it can be provided through less expensive means. Another example of opportunities to economize in furniture is in the building of storage facilities locally.

UTILITIES FOR THE SCIENCE ROOM

The nature of the work in science is such that it is essential to provide running water, gas, and electricity. These are available in most communities. In some situations, however, any or all of them may not be available. One that is often lacking is gas. If gas is not provided in the building, it is possible to provide this utility for science teaching in a relatively inexpensive way through the use of liquified gas. In some communities, 110-v. a.c. is not available. In such

instances, it may be possible to use a generator driven by a gasoline engine to provide the necessary electricity. Direct current can be provided through the use of dry cells and storage batteries.

An entirely satisfactory substitute for running water is yet to be found. However, there are relatively few schools that lack a source of running water, and there is adequate justification for installing the necessary water lines and drains for the science rooms. While it is desirable to provide several outlets in relation to the need in each science room, it is sometimes very difficult when buildings are remodeled to supply running water. The need for running water is such, however, that there should be no exception to the provision of at least one outlet in each room. In addition to such essential facilities, it is quite desirable in many situations to have compressed air and distilled water available.

RESOURCES IN THE SCHOOL AND IN THE COMMUNITY

A well-planned school building has many resources of great value to science teaching. The resources of the industrial arts department, of the agriculture and home economics departments, as well as those found in the school heating plant and the lighting system are all quite valuable to science teaching. The school ground itself will provide many resources. Such resources include the many growing plants found there, as well as opportunities to study the various animals that live on or near the school ground.

Access to the out-of-doors should be readily provided. In those schools where the science rooms are located on the first floor, a door leading directly from the science room to the out-of-doors is a major convenience, but is not essential.

The school community provides many resources for the teaching of science. While these resources vary a great deal from one community to another, most communities have many resources that are within walking distance. Others can be reached by relatively short travel. In many communities, there are gardens and farms that are useful to science teaching. In many, there are greenhouses and zoological parks. Many communities have industries such as dairies and canning factories that can make a contribution to the science work of the school. Museums are available to many schools, as are factories and other corresponding resources. The municipal light plant and the water system are worth-while resources for the teaching of science. Each school and community should be studied and appropriate administrative provisions made to render the resources for science teaching available.

RENOVATION OF SCIENCE ROOMS

In many schools, it is desirable to renovate science rooms in order to make them more useful. In some situations, the renovation involves the conversion of rooms previously used for other work to science teaching. In the planning of this renovation, such factors as orientation and attractiveness previously mentioned should be kept in mind. Renovation should take into account the use

of existing resources. For example, the location of a science room may depend on the accessibility of water lines previously installed. Thus, it is much easier to locate a science room next to a toilet than to a room that does not have running water. Other factors being equal, it may be placed profitably in such a relative position. Renovation should provide for attention to the lighting of the room, so that all areas have adequate levels of illumination for the tasks to be performed there.

GENERAL QUALITIES OF SCIENCE ROOMS

In the planning of new facilities and the renovation of old rooms, various general qualities must be studied by the school administrator, the science teacher, and the architect. Among these is illumination. There should be a careful study of the work to be performed at various points in the room and the necessary level of illumination at those points should be provided. The determination of such essentials is properly the function of the science teacher who should be an active participant at all stages of planning.

Ventilation presents a problem special in the teaching of science. Attention must be given at the planning stage to adequate ventilation for those areas that produce obnoxious odors. This is particularly true of rooms in which chemistry is taught and of the rooms used for biology. The odor of preservatives and the odors produced by living animals are examples of the problems to be solved. It is better in the usual situation to provide a separate room for living animals if it is at all possible. In this connection it is well to keep in mind that there are some pupils who are allergic to the fur of animals and must be safeguarded from this kind of exposure. A separate small room for animals meets this problem quite satisfactorily.

It is essential also in planning the room to make certain that the floors provided are resistant to acids, bases, and petroleum products. Certain recently developed materials are very promising in such qualities. Attention must be given to the waste lines that are provided to carry away the corrosive chemicals. Certain materials have proved to be quite satisfactory for this purpose.

SUMMARY

The provision of rooms for science teaching deserves careful planning because of the important place of science in the lives of people. The contributions of all qualified persons should be sought so that the facilities will be most effectively provided. A current study of school facilities for science instruction¹ will provide much help to school administrators, architects, science teachers, and others whose responsibility is the provision of an effective curriculum in science. This study is a joint project of the National Science Teachers Association and the U. S. Office of Education.

¹ This study will be available about March 1, 1953, from the National Science Teachers Association, 1201-16th Street, N.W., Washington 6, D. C. Write for price.

D. Materials for Laboratory and Demonstrations

HUGH E. BROWN

In this article, Mr. Brown surveys recommended equipment and materials needs for teaching general science, biology, chemistry, and physics, as recommended by several state and national groups. He analyzes the costs of these recommendations and tries to establish a conclusion about the typical cost of "average" instruction in high-school science in so far as equipment and materials for laboratory work and classroom demonstrations are concerned. Because of the diversity of needs throughout the nation, the writer declines to make specific suggestions as to what materials should be acquired, but he refers the reader to several such recommendations. In concluding the article, Mr. Brown also discusses the cost of equipment and materials for teaching a course in integrated physical science and for conducting a program of elementary-school science.

THESE seems to be no argument against the thesis that science and technology have made it possible for our country to produce and use the most of such things as automobiles, telephones, radios, television, and a host of other things that lead to better living. It is a logical conclusion that, for the men and women of the coming generation to have even more such conveniences, it is necessary that large numbers of our youth be given science instruction so as both to produce and use such products.

Laboratory exercises or experiments by the pupil have long been one part of the conventional way of teaching science. For college entrance preparation pupils, it is fairly universal; but, even for general education pupils, it is a very effective way of learning. Learning by doing is well recognized as more effective than learning by reading.

The next most effective way of learning is by seeing someone else do an experiment instead of just reading about it. Here is where demonstrations become the teaching method—whether the demonstration be done by the teacher or by one or more of the pupils before the class. Therefore we shall concern ourselves with equipment and materials for science teaching for both laboratory work by pupils and demonstrations by teacher or pupils.

The established science subjects in the high-school curriculum are general science, biology, chemistry, and physics. There are other specialized courses such as health, conservation, safety, meteorology, photography, aviation, consumer science, and physical science, which involve some science, but they are usually the outgrowth of special needs of a group of pupils that occur in the larger schools and which are not fully met by the regular science courses. To provide equipment and materials for all four of these established courses in

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science in the high school requires a considerable sum of money. However, adequately equipped science rooms are not more expensive than adequately equipped shops, music rooms, and gymnasiums. The actual items needed for science will depend somewhat on the character of the community. Thus, in cotton growing areas, the teacher will want to have a life history of the boll weevil. In localities where electronics equipment is manufactured, the teacher will want to have an oscilloscope.

It, therefore, becomes difficult to make a list of the equipment and materials that would be the most desirable selection for teaching any of the sciences. It is not the intention to do that here. However, such lists are available. Many state departments of education have lists of equipment and materials that they would like to see in each school of their state. A list was published some years ago by the U. S. Office of Education. Science periodicals have had some articles on the subject. Probably the most important list is the one now being prepared by the School Facilities Committee of the National Science Teachers Association. From the 6,000 members of this association there has been chosen a group which has studied the problem very thoroughly, and a volume is in preparation which should be of much help to teachers and administrators.

Even though a list of equipment and materials is not to be included here, it will be necessary to have a specific list in mind in order to be explicit as to the financial considerations. Therefore, examination was made of three lists published by three state departments of education and one published by a national study group. The lists have not been submitted to supply houses for current quotations, but the prices as given in the official publications will give an idea of the approximate financial consideration involved. A tabulation from these four lists follows.

STATE DEPARTMENT NO. 1

	<i>General Science</i>	<i>Biology</i>	<i>Chemistry</i>	<i>Physics</i>
Individual Apparatus.....	\$ 6.05.....	\$ 4.40.....	\$ 8.75.....	\$ 526.30
General Apparatus.....	153.83.....	258.60.....	168.75.....	
Chemicals.....	21.18.....	9.96.....	42.70.....	
Additional desirable demonstration apparatus.....	313.07.....	349.03.....	205.46.....	511.80
Live and preserved material.....		70.95.....		
TOTAL.....	\$494.13.....	\$692.94.....	\$425.66.....	\$1,038.10

STATE DEPARTMENT NO. 2

	<i>General Science</i>	<i>Biology</i>	<i>Chemistry</i>	<i>Physics</i>
Student Apparatus.....	\$ 14.27.....	\$ 7.86.....	\$ 17.62.....	\$ 292.27
General Apparatus.....	187.59.....	283.50.....	127.14.....	
Chemicals.....	28.05.....	18.00.....	108.18.....	
Live and preserved material.....		68.00.....		
Additional desirable demonstration apparatus.....				478.91
TOTAL.....	\$229.91.....	\$377.36.....	\$252.94.....	\$ 771.18

STATE DEPARTMENT NO. 3

	<i>General Science</i>	<i>Biology</i>	<i>Chemistry</i>	<i>Physics</i>
Individual Apparatus.....	\$ 13.46	\$ 9.91	\$ 18.34	\$ 297.48
Teachers Demonstration.....		479.30	221.52	390.06
General Apparatus.....	220.60			
Preserved material.....		23.45		
Chemicals.....	34.96		81.33	
Desirable.....	147.90			
Additional Recommended.....	262.95	411.30	342.13	434.15
TOTAL.....	\$679.87	\$923.96	\$663.32	\$1,141.69

NATIONAL STUDY GROUP LIST

	<i>General Science</i>	<i>Biology</i>	<i>Chemistry</i>	<i>Physics</i>
All Materials (Includes 20 microscopes).....		\$3,839.38		
Demonstration Apparatus.....	\$484.95		251.15	
General Apparatus.....	231.29		301.16	2,207.01
Desk Apparatus.....			352.23	
Student Apparatus.....			41.54	
Chemicals.....	155.60		107.64	
Desirable.....	108.75		301.40	1,354.12
TOTAL.....	980.59	3,839.38	1,355.12	3,561.13
AVERAGE OF ALL FOUR TOTALS	\$595.90	\$1,458.41	\$674.26	\$1,628.02

The variation among these lists—all very carefully made by educators and administrators—illustrates the difficulty of setting up a list and saying "This is it". There would also be a little better agreement if all details, such as the size of the class, the number of experiments to be done, the number of pupils working in a group on each experiment, and whether the experiments were rotated among groups, were carefully outlined. If we reduce the fourth biology list above by conceding that perhaps twenty microscopes is above the realm of likelihood for the average small or medium size school, we can draw some very valuable conclusion from a study of the above lists.

These lists might be thought of as representing good practice, not as complete as would be found in the best equipped schools, but, on the other hand, superior to the inadequate materials with which a good many of our schools struggle along.

The financial considerations of equipment and materials for laboratory work and demonstrations would be conservatively summed up by saying that general science and chemistry would require an outlay of better than \$500 and biology and physics would require an outlay of better than \$1,000. The expression "better than" is a very important one. It means that these committees believe that a good course in these sciences can be given with that amount of equipment. However, many of our better schools will inventory a larger amount than indicated in these studies. It is unquestionably true that a science course that is

rich in illustrative material is far more effective than one resorting only to reading pages of the textbook.

Even though the science room or rooms might conceivably be fully equipped to meet the outline of any of the four plans tabulated above, there will still be need for purchasing equipment and materials each year for the following reasons:

1. Breakage and deterioration will occur which will need replacement.
2. New devices, even new subject matter, appear, and, unless new things are added, the science instruction will not keep abreast of progress. Within the lifetime of many persons now teaching, there has come radio, television, radioactivity, petroleum cracking, hormones, plastics, and a host of scientific facts that the science teacher of twenty-five to fifty years ago could not teach because the facts had not yet been discovered.
3. Some materials are actually used up and consumed. Chemistry is the science that consumes most—chemicals are used and test tubes and glassware are broken. Other sciences also consume materials. These are relatively small items compared to the original outlay but should be considered. The usual procedure is that a per-pupil allowance be set up to replace consumables yearly. Many studies have been made to determine this amount and the values usually considered as a justifiable maintenance allowance is between \$2.50 and \$5.00 per pupil with the largest amount for chemistry.

Many science teachers put high on the list of necessary equipment and materials a set of tools. Often these include machine tools such as grinder, lathe, and drill press. They also include all sorts of hand tools and such supplies as screws and bolts of many sizes. Such a scientific shop is most useful to physics and general science departments. However, many useful pieces of equipment for teaching can be made for all the sciences including animal cages, mechanical models, charts, etc. A pupil who builds a piece of equipment will be found to have a thorough knowledge of the principles involved. In this way the science shop not only supplements equipment needs but it also becomes an effective teaching aid.

An encouraging word might be inserted here for the science teacher who has almost lost hope of securing adequate equipment. It is practically universally agreed that a great deal of helpful material may be obtained from the community, brought from the pupils' homes, or donated by industries in the vicinity. These sources are most valuable. Furthermore, they encourage community co-operation with the school. Also, a sizeable number of items may be made by pupils or the teacher in the school shop. However, no amount of ingenuity or activity by the pupil or the teacher in uncovering community sources or building things will replace to any sizeable degree the necessary equipment made of glass, rubber, porcelain, and metal and the supplies such as chemicals.

Thus far we have discussed the high-school courses of general science, biology, chemistry, and physics. Because of their increasing popularity, two other courses should be mentioned; *viz.*, senior science (or physical science) and elementary science (or science in the grades).

The former is generally a fused or generalized course in the physical sciences combining physics and chemistry with perhaps some geology, meteorology, and astronomy. Whatever the course is called, it is generally held that the fused

or generalized science course is preferable to the course in chemistry and/or physics for a general education program. However, it in no way replaces the sequential course in physics and chemistry for those pupils preparing for advanced training. Here again the "doing" or even the "seeing done" is a more effective way of teaching than by only reading a book. These courses vary so much in content and method that it is difficult to indicate even approximately what equipment and materials are needed. However, an examination of one of the textbooks offered for such a fused course discloses that, if the teacher demonstrated all of the principles discussed, it would require more than \$1,000 worth of equipment.

The other increasingly popular course in science is the teaching of science in the elementary school. Here is where the exploratory or discovery method may be used to its greatest advantage because of the uninhibited, enthusiastic curiosity of young children. But here again, "doing" or "seeing done" is a more effective learning method than by reading only. One southwestern city put in a program of this kind with a text, teachers manual, and a kit of equipment for each grade level. Pupils who progressed through this program from grade one through eleven and who, in grade twelve, took chemistry, were able to complete the textbook in one semester because of the amount they had already learned about oxygen, water, air, fuels, metals, etc. Many varied programs have appeared in recent years. The most successful have included sizeable lists of equipment and materials. Several states have outlined rather minutely the subject matter to be covered at each grade level and some have given a list of the equipment needed. One of the more ambitious programs has specified in the state syllabus a list of equipment amounting to more than \$300, not including a microscope. The same bulletin lists additional desirable equipment totalling about \$250 which includes only a very low-priced microscope. One of the less expensive sets of specifications for grade or elementary science appears in the April, 1952, issue of *The Science Teacher*. This list will cost about \$150 and does not include a microscope although microscope slides and cover glasses are included.

Lists of equipment and materials are of little value to the well-trained, experienced science teacher who will know what he wants and who will insist on it being supplied. However, a list put out by a professional group is a very great help to a beginning teacher or one who does not have a degree in the science he is teaching and whose first years of teaching are invariably in small schools which are the ones universally lacking in facilities of all kinds. Such a list serves not only as a guide to the teacher but also as "evidence to the administrator" that the science room or rooms need more facilities. The list will encourage the science teacher to ask for more equipment. It can be used as "ammunition" to persuade the administrator to provide better science facilities.

The writer has been in many science rooms in nearly every one of the forty-eight states including all types and sizes of schools. With the exception of some of the larger city schools, some endowed private schools, and some schools in

specially favored communities, he has not seen many schools that are adequately equipped. And he has never seen any school in which there were not many things that the teacher would like to have. The inescapable conclusion is that science rooms are generally woefully lacking in materials and equipment. Perhaps the greatest need is for recognition by principals, supervising principals, superintendents, boards of education, and all supervising personnel to realize this lack and decide to do something about it. A teacher who persuades his administrator to equip the science room better will not only teach more effectively but he will also endow that school with facilities which will enable his successors to teach more effectively for many years to come. Perhaps this is one of the missions of the science teacher. In the words of Mordechia to Esther, "Perhaps thou art come to the kingdom for just such a time as this".

E. Using Prepared Instructional Kits and Improvised Equipment

HUBERT J. DAVIS

In this article, Mr. Davis identifies two common shortcomings in science education—over-use of the textbook and over-reliance on teacher demonstrations—and proposes a remedy for each. To extend pupils' learning experience beyond their contacts with their own textbook, he describes the use of teaching kits—collections of printed materials on a given topic which can be borrowed by interested classes. To provide more pupil participation in experimentation, he suggests a wide variety of improvised and inexpensive, yet highly useful, science equipment. He concludes his article with a bibliography of things-to-do publications in experimental science.

THE most exclusive medium for education today is the printed word. This is usually provided by widely used textbooks. Thus reading, our most over-emphasized and under-taught subject in school, becomes the basic tool for learning. Fortunately, there has recently been a trend toward giving meanings to the printed word through the use of motion pictures, filmstrips, charts, direct experience, pictures, radio, tape recordings, exhibits, and the like. These necessary and effective teaching tools are not substitutes for, nor in competition with, the printed materials. The more such media are used, the greater is the need for a variety of well-selected reading materials to supplement and interpret them.

One rather generally accepted but undesirable practice in science education is the over-dependence on science textbooks. Another widely used practice is

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the use of teacher demonstrations as a substitute for pupil experiments. In this article, the writer will suggest a possible approach to each of these problems.

A very practical way to supply additional reading materials which get away from the textbook is through the use of teaching kits. The term *teaching kit*, as used here, implies a great variety of materials on many reading levels, dealing with a single topic, assembled and held together as a unit. Two purposes served by such kits stand out above all others. First, there is a very definite need for something to begin where the textbook ends. It takes years to plan and write a textbook. Once selected in a state where the state-adopted plan is required, it is likely to be used for several years. Before a new book gets into the classroom, it is already out of date. It is impossible for a science textbook to catch up with scientific research. The teaching kit helps to bridge this wide gap. Secondly, there is an abundance of free and business-industry sponsored materials available from many sources. Busy teachers find it very difficult to keep abreast of these materials. It is impossible for the individual teacher to have such materials on hand in sufficient quantities at such time that they are most helpful. But it is possible to help teachers solve this problem through the co-operative planning of science teachers, librarians, and pupils.

The kit service idea is well illustrated by a program for a large system with which the author recently has had the privilege of working. In this system, the need for science kits grew out of the numerous requests of high-school science teachers for supplementary materials. Working with these teachers and their librarians, pictorial and descriptive materials from many sources were assembled on specific topics in each school. This helped, but did not adequately meet all of the requests.

A group of biology teachers began a search for materials on local resources. Their requests for textual materials was met with a kit of booklets, bulletins, and books on marine life. A teacher committee was assigned the task of preparing a guide for the collection and preserving of marine specimens. When this was completed, other teachers, using the guide and with the help of high-school pupils, were able to assemble more than two hundred preserved marine specimens. This, along with two additional exhibits prepared later, was packed and placed on a loan basis to all of the schools in the division.

Later, when the interest shifted to reptiles, similar requests were received and met with a kit of bulletins and pamphlets. Again a teacher committee prepared a source unit on the more common reptiles found in the area. In due time, teachers and pupils collected and preserved enough specimens to make three complete lending exhibits.

Collecting specimens and preparing kits for county-wide use served as a stimulating challenge and a worth-while educational experience for pupils and teachers. The idea grew in popularity. Later a county-wide program was developed to prepare kits for a complete eighth-grade science course. This became a co-operative undertaking by all of the science teachers and supervisors.

INDIVIDUAL KITS PACKED FOR DISTRIBUTION

The kits were packed and kept ready for immediate shipment to the schools. A packing list showed the number and the title of each item in the kit. There were manuals, teacher handbooks, source units, and lists of available audio-visual materials in each kit. An individual kit was planned to supply enough materials for an average size class. Fifteen to thirty pamphlets were included on significant topics. Less important or more technical topics were taken care of with five or more pamphlets. Special books, identification keys, magazine articles, and hard-to-get materials were also included.

As the teachers became better acquainted with the kits, they asked for special materials to supplement them. For example, the marine life kit was supplemented by an exhibit of marine specimens, a kit of materials on shells, a kit of local shells for identification purposes, and a kit of fossil shells. Kits on nutrition were supplemented with models, living animals, and suggestions for conducting experiments with live animals. Other kits were supplemented with bulletin-board displays, special exhibits, and suggestions for field trips.

While the kits were originally planned for use in high schools, soon they were in great demand by the elementary schools. This popularity resulted from the great variety of reading levels represented by the materials, and the rich source of illustrative materials. Some kits, such as those on atomic energy and sex education, were often used by teacher study groups and lay committees.

The kits were loaned to teachers for a period of from three to six weeks for actual classroom use. Each month the science teachers met and planned their work. Such planning made it possible to serve a large number of class groups with a small number of kits.

The expense incurred in planning these kits was shared co-operatively by the county school board, the individual schools, and the pupils. They contained inexpensive science bulletins on many reading levels. All the free bulletins available on a given topic were used. A few rather expensive books of an encyclopedic nature were added. The cost ranged from as little as a few dollars for the atomic energy kit to seventy-five dollars for the more elaborate ones. The kits covered such topics as astronomy, atomic energy, conservation, cancer, diseases, electricity, healthy living, infantile paralysis, insects, lumber, marine life, fossil shells, sex education, local history, state history, minerals, rocks, soil, care of the eyes, tuberculosis, coal, nutrition, milk, business-industry sponsored materials, laboratory materials for elementary science, and mineral identification displays.

UNLIMITED POSSIBILITIES

The kit idea can bring to the classroom the educational services of many of our local, state, and national foundations. The tuberculosis association, for example, has a great variety of good teaching materials which lend themselves readily to kits. The National Foundation For Infantile Paralysis has enough

good materials to make a complete kit. Most state and local health agencies can assemble materials to make excellent kits. The National Dairy Council has an abundant supply of useful and attractive materials which can be assembled easily into kits.

The kits have been used in promoting in-service teacher training programs. More than two hundred excellent science bulletins sponsored by business-industry have been assembled and placed in many of our Mississippi schools to acquaint teachers with their source and possible uses. One can conceive of no better way to acquaint the new teacher with the abundance of good booklets, bulletins, and other materials on any topic than through a carefully planned kit.

TEACHING KITS SUPPLY ONLY PART OF THE ANSWER

The teaching kit supplies a variety of reading materials on individual reading levels. However, it is largely a supplement to the textbook, and does not adequately get away from science *a la* book. The use of pupil experimentation and improvised science equipment does offer escape from verbalism and provide opportunity for pupils to learn science as they should, *by doing*.

Two of the most important objectives in teaching science are teaching pupils to think and teaching them to apply the scientific method in solving problems significant to them. Obviously, these goals cannot be attained by teaching science out of textbooks alone. There is no substitute for the actual experience in applying the scientific method to simple problems. Learning by experimentation is the body and soul of good science teaching.

I do not mean experimentation as is often carried on by pupils blindly following directions—the "cookbook" experiment. This type of exercise is devoid of reflective thinking. Pupils not only fail to apply the scientific method, but may even develop habits and attitudes which are contrary to it.

Teacher demonstration is not a substitute for pupil experimentation. Demonstrations performed by a teacher who points out what is about to happen and suggests the possible outcomes provide the pupils little opportunity for reflective thinking. Demonstrations have a limited but a legitimate place in science teaching when they are carefully planned and skillfully performed. They may be used:

1. To acquaint pupils with apparatus and present accepted techniques
2. To raise new problems and test hypotheses
3. To provide exercises for pupil observations or give practice in drawing conclusions
4. To avoid having pupils perform experiments which may be dangerous
5. To perform experiments which may require difficult or skillful manipulation
6. To perform experiments which may involve delicate or scarce equipment.

But demonstrations, when used as a substitute for individual or small group experiments, serve only to deprive the pupils of the real thrills and benefits from science.

A common explanation of science teachers for not using individual experiments is that they have no equipment, materials, or laboratory manuals. Teachers

who use this as an excuse can be thinking only of the equipment, materials, and manuals used to teach them in high school and college. Laboratory manuals and elaborate equipment have no place in the elementary and junior high schools. If used, they confuse the pupils and draw their attention to the equipment rather than the problems to be solved.

It is a relatively simple matter to secure adequate materials and equipment and find suggestions for worth-while experiments. This is no problem for teachers who enlist the co-operative support of their pupils by giving them a real share in planning their science experiences. Such teachers confine their laboratory work largely to pupil-teacher selected activities. The pupils raise problems, suggest possible experiments, work co-operatively with the teacher to arrive at simple directions for performing them, plan their own equipment, assemble materials, and construct apparatus.

This procedure provides for creativeness, stimulates pupils to think, and gives them a real purpose for experiments. It enables groups and individuals to co-operate and share information. It develops resourcefulness. It helps to provide for individual needs and individual growth. The use of simple pupil-constructed equipment also serves as a powerful motivating device.

If the experiments are kept simple, and they should be, it enables the teacher and pupils to assemble common-place materials which are inexpensive and abundant in every school environment. A survey of the school and classroom will reveal many common devices and materials which may be put to use in the science class. The ten-cent store will provide materials such as balloons, batteries, lenses, magnifying glasses, thermometers, compasses, rulers, funnels, electrical supplies, and many other inexpensive items.

The corner drug store may supply photographic materials, alcohol, cotton, acetone, and many simple chemicals. The junk dealer will provide a variety of metals, old bells, batteries, clocks, automobile parts, and an untold number of useful gadgets. A thorough search of the attic, basement, and kitchen at home will provide paraffin, coffee cans, glass jars, wire hangers, scraps of plywood, wooden boxes, mailing tubes, knitting needles, magnets, doorbells, scraps of screen wire and window glass, old phonograph records, toothbrushes, string, corks, electric cords, electric sockets, lamp chimneys, flower pots, kitchen tools, pans, *etc.* The neighborhood garage and radio repair shop will have an abundance of discarded but useful items that may be very useful in the science program.

A kit of simple tools will be needed for this type of science program. Such tools as screwdrivers, pliers, tin-snips, hack saws, hammers, squares, hand drills, files, glass cutters, and the like may be obtained at the local ten-cent store at slight expense.

There is no place in the program for the "cookbook" type of manual to suggest what experiments should be done. Every important principle in science may be demonstrated through experiments. An exhaustive list of suggested

scientific principles will be found in *Science for the Elementary-School Teacher*.¹ Every pupil problem provides a basis for many carefully planned experiments.

The bibliography at the end of this article suggests hundreds of simple experiments and laboratory devices such as a razor-blade radio, water-drop microscope, milk-bottle compass, mayonnaise-jar rain gauge, milk-bottle air thermometer, fruit-jar barometer, phonograph-record paint, light-bulb stove, tin-can planetarium, lamp-chimney insect breeding cage, simple magnetizer, mailing-tube ventilation box, and many others.

Science teachers will profit greatly by examining these sources and using the many ideas given. But they should select only those which help pupils to improvise their equipment. They should stimulate pupils to apply their own resourcefulness and ingenuity in adapting these devices to make them respond to the simple treatment of the commonplace materials at hand. This will not only improve science teaching, but it will also amaze and please those who are able to tap the resourcefulness of the young mind.

BIBLIOGRAPHY

Selected Books

- Crouse, W. H. *Understanding Science*. New York: Whittlesey House. 1948.
- Freeman, M., and Freeman, I. *Invitation to Experiment*. New York: E. P. Dutton Co. 1940.
- Garrison, C. G. *Science Experiences for Little Children*. New York: Charles Scribner's Sons. 1939.
- Lord, Eugene H. *Experimenting at Home With Wonders of Science*. New York: D. Appleton Century. 1942.
- Lunt, J. R. *Electricity For Everyone*. New York: The Macmillan Co., Inc. 1943.
- Lynde, C. J. *Science Experiences With Home Equipment*. Scranton, Pa.: International Textbook Co. 1937.
- . *Science Experiences With Inexpensive Equipment*. Scranton, Pa.: International Textbook Co. 1939.
- . *Science Experiences With Ten Cent Store Equipment*. Scranton, Pa.: International Textbook Co. 1939.
- Mckay, H. *Easy Experiments in Elementary Science*. New York: Oxford University Press. 1932.
- Miller, David F., and Blaydes, Glen W. *Methods and Materials For Teaching Biological Sciences*. New York: McGraw-Hill and Co., Inc. 1938.
- Morgan, A. P. *Things A Boy Can Do With Chemistry*. New York: D. Appleton Co. 1940.
- Rush, Charles E., and Winslow, Amy. *The Science of Things About Us*. Boston: Little Brown and Co. 1931.
- Richardson, John S., and Cahoon, G. P. *Methods and Materials For Teaching General and Physical Science*. New York: McGraw-Hill Book Co., Inc. 1951.
- Schneider, H., and Schneider, N. *Now Try This*. New York: William R. Scott. 1948.
- Swezey, Kenneth M. *After Dinner Science*. New York: Whittlesey House. 1948.
- Yates, Raymond F. *Science With Simple Things*. New York: D. Appleton Century Co. 1940.

¹ Craig, Gerald S., *Science for the Elementary-School Teacher*, New York: Ginn and Co. 1946. 351 pp.

Selected Pamphlets

Arey, Charles K. *Science Experiences for Elementary Schools*. New York: Bureau of Publications, Teachers College, Columbia University. 1942.

Association For Childhood Education. *This is Science*. Washington, D. C.: Association For Childhood Education. 1945.

——— *Uses for Waste Materials*. Washington, D. C.: Association For Childhood Education. 1951.

Blough, Glen O. *Elementary Science Series*. Washington, D. C.: U. S. Government Printing Office. 1947.

Blough, Glen O., and Blackwood, P. E. *Teaching Elementary Science*. Washington, D. C.: U. S. Government Printing Office. 1948.

——— *Science Teaching in Rural and Small Town Schools*. Washington, D. C.: U. S. Government Printing Office. 1949.

Bruce, Guy V. *Experiments with Water*, Vol. I. Washington, D. C.: National Science Teachers Association.

——— *Experiments With Air*, Vol. II. Washington, D. C.: National Science Teachers Association.

——— *Experiments With Fuels*, Vol. III. Washington, D. C.: National Science Teachers Association.

——— *Experiments With Heat*, Vol. IV. Washington, D. C.: National Science Teachers Association.

——— *Experiments with Magnetism and Electricity*, Vol. V. Washington, D. C.: National Science Teachers Association.

——— *Experiments With Sound*, Vol. VI. Washington, D. C.: National Science Teachers Association.

——— *Experiments With Light and Color*, Vol. VII. Washington, D. C.: National Science Teachers Association.

Cook, Sherman R. *Things to Make and Do With Dry Batteries*. Freeport, Ill.: Burgess Battery Co.

Davis, Hubert J. *The Coming of Spring*. State College, Miss.: Dept. of Adult Ed., Mississippi State College. 1952.

——— *Some Handy Recipes for Science Work*. State College, Miss.: Dept. of Adult Education, Mississippi State College. 1952.

Denslow, Cornelius. *Elementary Science*. Darien, Conn.: Educational Publishing Co.

——— *Nature Collections Merit, Badge Book # 3198*. New York: Boy Scouts of America.

Gardner, Martin. *Magic For the Science Class*. New York: Scott Foresman and Co.

Gordon, Bertha F. *Prove It Yourself*. Dansville, New York: F. A. Owen Publishing Co.
Instructor Series of Illustrated Units. F. A. Owen Publishing Co.

CHAPTER IV

Aids to Instruction in High School Science

A. Textbooks, Workbooks, and Laboratory Manuals in Science

NATHAN A. NEAL

In this article, Dr. Neal summarizes several modern views on the purpose of general education in American high schools. He follows this with a strong statement on the influence that textbooks can and do have on the nature of secondary-school instruction. Building upon this foundation, he discusses the ways in which high-school science textbooks do contribute toward the aims of general education, and how their contribution might be improved. In this manner, he treats attitudes about conservation, development of consumer competence, and education in health and safety. The article is concluded with a discussion of some of the strengths of workbooks and laboratory manuals as used in our high schools.

RATING scales and the mechanical organization of material in science textbooks have been discussed in various journals in recent months. For example, see the *Phi Delta Kappan*,¹ the *Science Teacher*,² and *Science Education*.³ This discussion will approach the subject of science textbooks in terms of contributions that may be made to broad objectives in the field of secondary-school general education.

In recent years, there has been clarification of the need for improved general education for all American youth. At administrative levels, it seems safe to say this subject has become a matter for implementation, no longer for discussion only. The administrator usually wishes to translate policy into practice in every feasible way. Thus the textbook, an omnipresent fact in secondary-school classrooms today and probably for decades to come, may offer one approach to improved general education.

POLICY STATEMENTS ON GENERAL EDUCATION

Clarification of the purposes of general education has come from many sources. Four will be cited here in an effort to indicate broad directions which science textbooks increasingly may follow:

¹ Waterman, Ivan R. "When You Choose a Textbook." *The Phi Delta Kappan*, 33:267-271, January, 1952.

² Vogel, Louis F. "A Spot Check Evaluation Scale." *The Science Teacher*, 18:70-72, March, 1951.

³ Crombie, Charles W. "Selecting Science Textbooks." *Science Education*, 35:276-278, December, 1951.

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1. The purpose of general education is to meet the needs of individuals in the basic aspects of living in such a way as to promote the fullest possible realization of personal potentialities and the most effective participation in a democratic society.⁴

2. Schools should be dedicated to the proposition that every youth in these United States—regardless of sex, economic status, geographic location, or race—should experience a broad and balanced education which will (1) equip him to enter an occupation suited to his abilities and offering reasonable opportunity for personal growth and social usefulness; (2) prepare him to assume the full responsibilities of American citizenship; (3) give him a fair chance to exercise his right to the pursuit of happiness; (4) stimulate intellectual curiosity, engender satisfaction in intellectual achievement, and cultivate the ability to think rationally; and (5) help him to develop an appreciation of the ethical values which should undergird all life in a democratic society.⁵

3. The case for the "common learnings" course is, in my opinion, unassailable. The argument runs somewhat as follows: It is the responsibility of the secondary school to aid society in carrying on the basic social processes. . . . It is also the responsibility of the secondary school to nurture youth in reference to all types of wholesome growth—to aid them in performing their developmental tasks. . . . A few words epitomize the potential significance of the common learnings course. Never in the history of man has so much hinged on the race between education and catastrophe. . . . In such a context the common learnings course may easily prove to be the most important social invention in the history of secondary education to date.⁶

4. Developing a Curriculum for Modern Living,⁷ a statement of "what students need to know to become capable of coping intelligently with their lives," adds concreteness to the aims of general education through re-appraisal of basic curriculum issues. This study urges the definition of "what students need to know" in terms of persistent life situations. It calls for education in our democracy to provide maximum growth in individual capacities, maximum growth in social participation, and growth in ability to deal with environmental factors and forces.

THE INFLUENCE OF THE TEXTBOOK

There are widely divergent points of view on the place that textbooks should hold in education. But today there is hardly any secondary-school situation in which textbooks are not used in some form. In many school situations, there is no influence that does more to determine what is taught. This situation has long held and continues in general practice.

Lampkin's study asserted the influence of the textbook: "Textbooks powerfully influence the scope, sequence, and method of instruction."⁸

Caswell and Campbell found a similar relationship: "Traditionally, scope of work in American schools is determined by the organization and content of textbooks."⁹

⁴ Progressive Education Association. *Science in General Education*, p. 23. New York: D. Appleton-Century Co., 1938. 591 pp.

⁵ Educational Policies Commission, *Education for All American Youth*, p. 21. Washington, D. C.: National Education Association, 1944.

⁶ Hand, Harold C. "The Case for the Common Learnings Course." *Science Education*, 32:5-11, February, 1948.

⁷ Stratemeyer, Florence B., et al. *Developing a Curriculum for Modern Living*. New York: Bureau of Publications, Teachers College, Columbia University, 1947. 558 pp.

⁸ Lampkin, Richard H. *Variability in Recognizing Scientific Inquiry: An Analysis of High School Textbooks*, p. 79. New York: Bureau of Publications, Teachers College, Columbia University, 1949. 80 pp.

⁹ Caswell, Hollis S., and Campbell, Doak S. *Curriculum Development*, p. 142. New York: American Book Co., 1935. 600 pp.

Hopkins, in deploring the dependence of teachers on textbooks, recognized the relationship: "For the past hundred years, the textbook has been the most important single tool which the teacher has used in her work. It has defined for her the meaning of education, methods to be used, and the outcome to be expected."¹⁰

In the field of science, there are various reports of the place and use of the textbook. Smith¹¹ showed a positive relationship between items learned and occurrence in textbooks. Malter¹² found that certain types of illustrations in general science textbooks could be used to advantage to reduce verbalism. Graham¹³ studied and reported topics covered in junior high-school science. His evidence indicated that teachers depend largely on their textbooks in determining course content.

Simmons¹⁴ pointed out that all aids for teachers found in textbooks add to the effect that textbooks have on teaching. Exercises, demonstrations, experiments, projects, questions, reports, references, footnotes, glossary, key statements, key words, pictures, summaries, tables, tests, and topic surveys make learning easier for pupils, and help the teacher to meet individual pupil differences. Obourn¹⁵ reported that textbooks help in the assimilation period of learning and also in the application of scientific methods and principles.

These statements by educators on the importance that the textbook holds in education may be compared with one opinion from textbook publishers. A recent report from publishers says: "The one teaching implement so universally used as to be a social phenomenon of the first magnitude is taken almost too much for granted."¹⁶

Observation indicates that textbooks provide in-service teacher training. Large numbers of teachers are influenced by the teaching procedures suggested in textbook prefaces and chapter-end exercises. Workbooks, laboratory manuals, printed subject matter tests, and teacher's manuals that accompany textbooks also provide in-service teacher education. In many cases today, the textbook and its accompanying publications constitute the most important source of in-service training in methods of teaching. Therefore, it may be expected that textbooks which recognize persistent life situations should influence practice in the direction of more attention to the aims of general education.

For the purposes of this discussion, let us assume that textbooks do influence practice. Let us further assume that we are agreed on some of the previously

¹⁰ Hopkins, L. Thomas. *Curriculum Principles and Practice*, p. 564. Chicago: Benj. H. Sanborn and Co., 1929, 617 pp.

¹¹ Smith, Victor C. "How Is Difficulty of Subject Matter a Factor Affecting Learning General Science." *Science Education*, 30:19, February, 1946.

¹² Malter, Morton S. "The Use of General Science Textbook Illustrations." *School Science and Mathematics*, 48:459, June, 1948.

¹³ Graham, C. C. "Some Data Pertinent to Textbooks of General Science." *Science Education*, 35:5, February, 1948.

¹⁴ Simmons, Maitland P. "Changing Conceptions of Teaching Helps in General Science Textbooks." *Science Education* 20:211, December, 1936.

¹⁵ Obourn, Ellsworth S. "The Use of the Textbook in the Effective Learning of General Science." *School Science and Mathematics*, 35:285, March, 1935.

¹⁶ American Textbook Publishers Institute. *Textbooks in Education*, p. 8. New York, 1949, 139 pp.

indicated persistent problems of living with which general education of secondary-school youth is concerned, and to which textbooks in science and other school subjects may well give attention.

In 1751 at the founding of the Philadelphia Academy, Benjamin Franklin characterized much of the next century and a half of instruction in science when he said: " 'Histories of nature' should be read by young people who intend to become merchants in order that they may better understand the commodities which they sell, by those who intend to become craftsmen in order that they may learn how to use new material, and by those who intend to enter the ministry in order that they may better understand proofs of the existence of God and present them more satisfactorily."¹⁷

One may recognize in this statement made more than two hundred years ago some resemblance to certain problems that persist today. We still believe that, to the extent possible, science textbooks should treat their subject matter for the benefit of those who intend to become merchants or craftsmen. Witness units in modern science textbooks with titles such as: "Using and Controlling the Natural Environment," "Securing a Living Through Science," "Transporting People and Materials," "Communicating with One Another," and "Living in Today's World."

These are areas in general education which may be further broken down into persisting problems. "Using and Controlling the Natural Environment" has been subdivided in science textbooks into problem topics such as: How Does Man Use the Ocean of Air? How Is Weather Predicted? How Does Man Use the Earth's Layers?

Science textbooks subdivide "Transporting People and Materials" as follows: How Does Man Travel and Move Materials Over Water? How Is Steam Power Used for Transportation? How Have Liquid Fuels Modernized Transportation? How Is the Automobile Affecting Modern Living? How Is Electricity Used in the Advances of Transportation? Under "Communicating with One Another," we find science textbooks asking and answering: What Is Sound? How Are Different Musical Sounds Made? How Are Sounds Recorded? How Do Modern Telegraph, Wirephoto, Radio, Radar, Telephone, Television, and Facsimile Instruments Operate to Affect Your Life?

General education is concerned with perhaps even more significant persisting problems in social, personal, and economic areas of living where science teaching and textbooks have a contribution to make. Examples observed as units in science textbooks include: "Conservation of Human and Natural Resources," "Obtaining and Using Consumer Goods and Services," "Maintaining Healthful Living," "Securing Safety," "Continuing Life on the Earth," and "Atoms in Action."

¹⁷ Progressive Education Association, *Science in General Education*, pp. 6-7. New York: D. Appleton-Century Co., 1938. 591 pp.

SCIENCE TEXTBOOKS AND CONSERVATION ATTITUDES

Conservation, a major concern of general education at the secondary-school level, is widely treated in contemporary science textbooks. The following is a statement of information and points of view derived from examining a number of science textbooks in use today. It may be safe to assume that pupils using these textbooks will achieve some of the points of view suggested in this brief summary.

The depletion of natural resources—soil, water, certain types of living things—is a matter of national and world-wide concern. Attitudes that focus on wise use of natural resources are a goal of secondary education. Such will continue to be one of the concerns of modern civilization.

Older cultures apparently have toppled because of loss of topsoil from the land. It is said that in the United States this basic resource is now depleted by one third through erosion. It is said that another one third could be lost if it is allowed to fall prey to the possible effects of wind, water, and the tractor-powered plow. Much of the factual background required for understanding the urgency of the issue is now effectively transmitted through textbooks in the biological and physical sciences.

Water resources present persistent problems. Water from wells along the seaboard has become salty to taste. Wells by the thousands in the central states have gone dry, to be replaced by more wells driven deeper to reach lowered water tables. It is said that a little further dropping of the underground water tables will render certain fertile regions no longer suitable for growing food.

Some of the nation's largest cities, population centers of millions of human beings, exist with short reserves of water. Floods and droughts are accentuated in some regions by careless land usage. Supplying both food and water for the people of the world is complicated by the growing lack of water in the places needed at the time needed. The only sensible long-view solution to this persistent situation is to take whatever steps are necessary to put fresh water back into the soil of the earth's surface. Adequate methods for doing so are known and are in practice on a small scale in various locations. Science textbooks have an opportunity and an obligation to present the physical and biological facts in this area of educational activity.

General education may help to produce favorable conservation attitudes in the related areas of wildlife preservation, reforestation, and reclamation of denuded lands. More people should be aware of and take part in community, regional, state, and national planning for such conservation measures. Future broad planning and action for a balanced system of using resources are possible only to the extent that education along this line succeeds today. The need for intelligent thinking and action on conservation has various ramifications. One is in the use of replaceable materials, bringing reduced loss of non-replaceable substances. Plastics, for example, which come from air, water, coal, cotton fiber,

and soft woods, often may take the place of products originally made of metal or hard wood. Responsibility for the conservation of resources is a recurring theme throughout the whole of general education and science textbooks are a vital channel for conservation education.

SCIENCE TEXTBOOKS AND CONSUMER COMPETENCE

Another example of how science textbooks may aid the administrator in translating policy into practice is in the area of consumer education. An examination of consumer education materials in textbooks in general science, biology, physics, chemistry, and combined physical science provokes the following thoughts:

Consumer problems have their roots deep in fundamental changes in our social and economic life. One desirable outcome of general education is to reduce the gap between the best scientific knowledge relating to consumer commodities and the ignorance of large numbers of consumers. People are often prevented by lack of scientific understanding from making fully intelligent choices and use of foods, vitamin preparations, and medicines—to mention a few examples. Further, even the science that they do know may be exploited by pseudo-scientific advertising and sales promotion.

Problems of intelligent consumership recur in most of the major activities of living. Examples include acquiring a home; purchasing food, fuels, and clothing; buying and operating an automobile; selecting recreational equipment; and using medical supplies. A look at the breadth of these experiences indicates that the majority of people need scientific bases for evaluating the quality of merchandise. Science textbooks, workbooks, and laboratory manuals can render important service by giving pupils experience and practice in the techniques of assembling and interpreting evidence. Extended into adult life, these techniques provide a basis for intelligent attitudes, choices, and actions.

Competence in securing adequate housing, a highly desirable outcome of general education, implies application of numerous facts and principles of science. The nature and quality of materials for construction merit attention in science textbooks. Efficient maintenance and operation of a home also involves application of knowledge from the field of science.

Selection of clothing is a major consumer area where gaining optimum values depends, among other things, on application of some knowledge of science. The relative importance of fashion and health may be judged to better advantage if one understands the health facts. The increasing range and complexity of materials in furs, footwear, and textiles make their selection and care a somewhat technical matter—one in which related scientific information in textbooks is needed.

HEALTH AND SAFETY MATERIALS IN SCIENCE TEXTBOOKS

Space limitations permit only the briefest review of ideas gained from examining health and safety materials in contemporary secondary-school science

textbooks. Matters of health are of cardinal importance. Perhaps no other aspect of general education is more significant. Probably there is no other area in which science textbooks have as great an opportunity and obligation to make a contribution to general education.

The need for application of new knowledge in personal and community health seems likely to remain as long as science and progress are with us. Techniques for building health habits and attitudes have apparently not kept pace with the development of scientific knowledge. The facts and principles of health are functional with the learner largely to the extent that they are presented in relationship to his own living. There is need for a more direct approach to some health problems. Health knowledge is useless if social taboos prevent its application. A criterion for the selection of textbook material in health is the degree to which it is likely to influence pupils in their choices, actions, and attitudes.

Scientific development has brought new hazards as well as new comforts to living. Safety in the home, in industry, on the highway, in the air—and a developing aspect, safety from the effects of radioactive discharges—are concerns of general education.

All of civilized mankind is concerned with the potential problem of saving itself from the destruction of radiation—a problem which defies the combined efforts and intelligence of world leaders today, but one which is also the concern of every pupil, teacher, and citizen. Much needed information about the injurious effects of radiation is not yet available, but it is an obligation of science textbooks to do as good a job as can be done for "atomic age education." Science textbooks are perhaps the most appropriate to present and discuss from the safety point of view the physical, biological, and general health aspects of atomic radiations.

Many of the rules of safety in modern living have their basis in scientific facts or principles. An understanding of these aspects of science may bring higher regard for safety precautions. There are obvious safety implications to be brought out in connection with the study of fire and combustion, stimulants and narcotics, and the laws of motion, friction, force, energy, inertia, and falling bodies. The same holds true for motors, electrical devices, and the chemical products commonly used in the home, including those in the home medicine chest.

Safety education may lead to greater safety through extending safety consciousness. Knowing the hazards of common injuries such as cuts, burns, and skin punctures may encourage preventative measures. Textbook attention to first-aid techniques for treating these difficulties may accentuate safety consciousness.

The foregoing are examples of what science textbooks are contributing and will increasingly contribute to the conversion of general educational policy into practice. There is much more to be accomplished. Textbook publishers readily agree with administrators and teachers that their product has not attained perfection. However, the typical responsible textbook publisher follows a career of

searching for improved materials, more useful methods of presentation, and always more effective techniques that are possible on the printed page.

WORKBOOKS AND LABORATORY MANUALS

Workbooks for use in connection with secondary-school science textbooks have recently been discussed at greater length than space permits here. Those who argue for the present type of workbook usually hold that it should be possible to do better workbooks—publications which would offer inspirational type thinking exercises on a variety of levels for pupils of differing abilities. These same proponents also say that cost and time limitations usually prevent the publication and use of the type of workbooks which it is claimed would be desirable. Arguments in favor of the usual read-the-book, fill-in-the-blanks, type of workbook are:¹⁸

1. It saves teacher time spent in writing exercises, and other workbook materials on the blackboard for pupils to copy and use.
2. The preparation of workbooks—objective exercises, suggested activities, review questions—requires greater skill and more time than most teachers have for this phase of their work.
3. Workbooks assure study guidance for all pupils.
4. Workbooks assure some pupil time spent on daily homework.
5. Workbooks give practice in following printed instructions—an activity that is common in adult life.
6. Workbooks usually contain illustrations accompanied by sufficient exercises and questions to give the pupil real experience in interpreting illustrations or diagrams.
7. Workbooks provide practice in reading for information rather than merely for pleasure, a skill which young people need to develop.

Those who argue¹⁹ that present type workbooks are worse than none label them as a hodge-podge of poorly selected, poorly organized, pedagogically unsound teaching devices. They observe that workbooks are often constructed in the cheapest possible manner with poor typography, low-quality paper, cramped writing space, and are inconveniently sized. It is further argued that time devoted to routine workbook exercises, questions, and tests could be better devoted to simple experiments, field trips, observations, and activities that are more stimulating and satisfying. A publisher might answer that publication of the best possible workbooks would be as costly in time, editorial effort, and money as textbooks, and that the product would necessarily be priced outside any existing market for workbooks.

We find similar arguments applied to laboratory manuals for secondary-school science. There are some who oppose published manuals because they tend to standardize pupil activity in the laboratory and discourage learning through individual experimentation. The critics often refer to even the best published laboratory manuals as "cookbooks." They argue that the only good laboratory manual is one made by the teacher on the job each year after he is acquainted

¹⁸ Hudspeth, Jack. "Workbooks—? Yes." *The Science Teacher*, 18:74, March, 1951.

¹⁹ Zim, Herbert S. "Workbooks—? No." *The Science Teacher*, 18:75-76, March, 1951.

with the interests and abilities of individual pupils. The *pro*-arguments are to the effect that there would be much less laboratory work without printed manuals, that pupils with special abilities can design their own individual experiments; that the great majority need proved and printed procedures in order to achieve any results; that teacher time is saved; that expensive laboratory materials and equipment are conserved; that the printed laboratory manual need not be a "cookbook" in the hands of a skillful teacher.²⁰

²⁰ Oppe, Greta "Workbooks—Worktexts—Laboratory Manuals," *Metropolitan Detroit Science Review* Vol. XII, No. 4, 1952.

B. The Contribution of American Industry to Science Teaching

LOUIS M. STARK

In this article, Mr. Stark briefly outlines the development of relations between business-industry and education, and then describes some of the educational functions of the industry he knows best, the Westinghouse Electric Corporation. In this connection, he discusses the School Service Department, with its offerings of teaching aids in the form of pamphlets, charts, kits, *etc.*, he points out the policy of no advertising in such materials and describes some of the detail which goes into the preparation of such aids. This industry's series of educational radio programs is brought under discussion, as are its Science Talent Search and its program of scholarships and fellowships. In conclusion, the writer discusses the formation of two special groups of N.S.T.A., the Advisory Council on Industry-Science Teaching Relations, and the Business-Industry Section, with its well-known "packet service" to N.S.T.A. members.

ONE of the significant aspects of science education today is the contribution business and industry make to the enrichment of classroom teaching. Today many industries have special departments set up especially to serve the schools, largely in the field of science. These departments often are manned by experienced educators. They consciously try to interpret the know-how of their industries in forms valuable to the schools. They develop booklets, charts, posters, motion pictures, models—all sorts of teaching aids for classroom use. They make technical papers available to science teachers and help underwrite programs for science teacher workshops and summer fellowship programs. They offer scholarship awards and other incentives to young science pupils.

The materials and services offered by industry are widely accepted and used by the schools. They serve to bridge the gap between the textbook and the

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present-day world of scientific and technological progress. They help teachers to bring their own store of information up-to-date and to inject vital and stimulating material into their classroom work.

Industry has always welcomed and responded to requests from the schools for information. However, until not very long ago the schools and industry each went its separate way. Businessmen didn't have much to do with education, and educators didn't care very much about the manufacture and sale of goods and services.

This began to change swiftly about the time of World War II. The flow of requests for information from the schools started to increase rapidly, and industry responded accordingly. At Westinghouse, a School Service Department was set up in 1942 to handle requests from schools and to develop materials suited to school needs. The activities of that department typify the effort industry has made to co-operate with the schools. Since they are most familiar to me, I should like to review them briefly as one example of what one company is doing to contribute to science education.

Since its start, the School Service Department has handled more than 600,000 requests from the schools for materials and information. Beginning with a few modest offerings, it now publishes a catalogue of teaching aids each year which lists some eighty-five different instructional aids. Each year, it distributes about three million items to the schools on request.

A large part of our department's work has to do with the production and distribution of teaching aids. These take the form of booklets, charts, posters, transcriptions, motion pictures, cartoon-books—even a learning kit which contains all the parts of a workable one-fourth horsepower motor. Most of the materials are free. Some are available at a nominal charge. They all reflect different phases of the company's life in such fields as generation and distribution of electric power, home appliances, nutrition and cooking methods, electronics, jet propulsion, nuclear energy, industrial applications of electric power, lamps and lighting, and so forth.

A majority of the teaching aids are specifically designed for school use by people on the staff with backgrounds of experience in education. Other materials were originally prepared by the company for other purposes, but are made available to the schools because of their educational value. A good example of this latter class of material is a full-color cutaway chart of a turbojet engine, originally prepared for training classes and other locations where Westinghouse jet engines are used, but now an item in very popular demand from teachers.

One of the department's most popular items was conceived the day after the atom bomb fell. It is a booklet entitled *The World Within the Atom*, a simple, readable well-illustrated story on nuclear energy produced as soon after Hiroshima as possible. The first announcement of this booklet brought orders for more than one million copies.

Later, when the demand for more detailed information on atomic energy arose, a set of six charts on Nuclear Physics was developed. This set of charts, accompanied by a 36-page *Teachers Guide*, sells for one dollar a set. The department has sold about twenty thousand sets of these charts, mainly to the schools, but a good number to the Atomic Energy Commission, training institutions connected with the Armed Forces, and colleges and universities.

Like all other companies that have well-developed school programs, Westinghouse is very careful not to use the schools as a medium of advertising. The company name appears on all publications. Teachers generally want this in order to know the publisher. But anything that might be interpreted as objectionable advertising is carefully avoided. Any such interpretation put upon the materials would have the effect of arousing resentment and bad will on the part of educators—precisely the opposite of the kind of response desired.

A great amount of care goes into the making of a teaching aid. Soon the department is planning a new science and social studies aid on the junior high-school level. The staff has been working on it for about a year and a half. They have inquired about its feasibility from the forty-eight state departments of education and school administrators in twenty large cities, and have studied dozens of state and local curricula. For nearly a year, they have been working with a consulting committee from NEA headquarters in Washington—specialists in the social studies, elementary education, science and audio-visual instruction. The material was used in preliminary form under classroom conditions with fifteen classes in six schools distributed geographically throughout the country before final production on it was started. The care surrounding the development of this teaching aid is a little more elaborate, perhaps, than in most of the department's projects, but it illustrates the regard the department has for advice and guidance from educators.

In addition to preparing and distributing classroom materials, the School Service Department engages in a number of other educational activities. Each week it prepares a program for the *Adventures in Research* radio series. This is a transcribed, 15-minute, dramatized science series carried on commercial and educational radio stations in virtually every part of the United States and on the sixty-four stations of the Armed Forces Radio Network in their seven theaters of operation all over the world. It is also programmed by most of the seventy-eight members of the Intercollegiate Broadcasting System, in colleges and universities throughout the country. Radio Free Europe is now translating the scripts into several foreign languages for beaming to Iron Curtain countries, and the Voice of America is considering use of the series as one of their features. Three hundred transcriptions of *Adventures in Research* have been deposited with the United States Office of Education for loan-distribution through their Script and Transcription Exchange. Also, most of the stations which carry the series turn the transcriptions over to the local schools for deposit in a transcription library, from which teachers may borrow them.

Another aspect of the company's educational activities is the provision of a wide range of scholarships and fellowships. The oldest group of scholarships are the Westinghouse War Memorial Scholarships, which honor Westinghouse employees who served in the World Wars, and were established in 1919. These are 4-year grants valued at \$2,000 each at any accredited engineering college in the country. The War Memorial Scholarships are open to sons of employees of the company or to junior employees.

Most of the company's scholarships and fellowships are made available through funds granted by the Westinghouse Educational Foundation. Probably the best known of these are awarded through the Science Talent Search. This is a program conducted by Science Clubs of America. Each year the finest talent in America's high-school graduating classes is searched to select the three hundred top young scientists. Two hundred sixty of these are awarded honorable mention. Their names are sent to colleges and universities all over the country, and many of them receive scholarships because of this recognition of their abilities. The remaining forty are taken to Washington, D. C., for a 5-day Science Talent Institute, where they also share in \$11,000 in scholarships.

The Westinghouse Educational Foundation also provides the George Westinghouse Scholarships for boys with engineering promise. These are 4-year grants at Carnegie Institute of Technology, and \$28,500 is given annually to ten boys picked on a nation-wide basis.

Through grants by the Educational Foundation, Westinghouse gives two groups of summer fellowships to teachers of science. One is at the Massachusetts Institute of Technology, the other at Carnegie Institute of Technology. Each summer as many as fifty science teachers, selected by each of these universities, spend six weeks in a co-ordinated program of studies, which provides basically a review of fundamental subject matter and a survey of recent scientific developments.

This, then, is a brief summary of what just one company does in the field of secondary-school science teaching. To comprehend the contribution industry as a whole is making to science teaching one would have to multiply this many fold. Other large companies doing similar work can be counted by the dozens. Teachers can get aids in science from the automobile manufacturers, oil companies, railroads, airlines, and steel companies. They can get material on coal, chemical products, lumber, aluminum, rubber, gas, electricity, water, textiles, food, watches, machine tools—on almost any product or process which has a vital place in our world today.

Late in December, 1947, the National Science Teachers Association invited a number of industries to join with them in discussions of industry-science teaching relations. Some 300 industries expressed interest in this conference, and about ninety sent representatives to the meeting. From this meeting grew one of the first and one of the strongest official bonds between people in industry and people in science education. It was at this meeting that the idea for the

Advisory Council on Industry-Science Teaching Relations was formulated and approved.

The Advisory Council, which had its first meeting in Atlantic City on February 21, 1948, was originally composed of eight men from industry and eight science educators. The membership has since expanded to ten representatives from each group. It set out to develop a five-point program for the development of industry-science teaching relations—the so-called CEDUR program, standing for consultation, evaluation, distribution, utilization, and research. Through the activities of the Advisory Council in the CEDUR program, many new trails have been blazed enabling industry to obtain consultation and evaluation services by educators in the development of science aids and science programs, distribution of acceptable materials to science teachers, information on utilization of industry-sponsored aids, and access to research findings on basic questions in this field of endeavor.

The effectiveness of just one aspect of this program can be grasped from the results of the Packet Service—a distributive service brought into existence through the efforts of the Advisory Council. The Packet Service carries packets of up-to-date industry-sponsored science material to science teachers three or four times a year. Now in its fifth year, the Packet Service has delivered about three million copies of booklets, pamphlets, charts, and the like from well over one-hundred different sponsors. All the materials have been evaluated by teams of science teachers, and all have been found schoolworthy.

In December, 1950, another organization was born which promises to contribute much to this same effort. That is the Business-Industry Section of the National Science Teachers Association. Originally, the Business-Industry Section was brought into existence in order that the representatives of industry on the Advisory Council could represent something more than just their own companies. As elected or appointed representatives from the Business-Industry Section, they speak for a fairly large body of companies. The Section still serves this important function and also has a life of its own.

Today the Business-Industry Section has about 125 members representing about seventy-five different industries. And the group is growing rapidly. Local chapters have already been started in Pittsburgh, Washington, Boston, and Los Angeles, and other chapters are in the making. The local chapters will enable local business and industry to share in the benefits of organization and, thereby, enrich their contribution to science teaching on the local level. They will also probably stimulate local action programs, such as plant visits, teacher-industry roundtables, workshops, and the like.

The Business-Industry Section makes possible group sponsorship by industry of valuable programs for science teaching. As an example of this, the Section raised funds for a reprint and mailing to all NSTA members of the May, 1951, issue of *Scientific American*. This issue brought before science teachers the vital story of scientific manpower needs.

There are other working committees and groups composed of educators and businessmen that have done effective jobs in improving and developing industry-science teaching relations. The Business-Industry Section of the NSTA has the distinction, however, of being the only group that is officially a part of an educational association. This signifies that strong bonds of trust and mutual interest have grown up between these two groups which once went their separate ways. This affiliation provides more opportunity than ever before for representatives of business and industry to meet with educators on a common footing and to work out co-operative programs. It should almost certainly lead to more effective efforts on the part of industry to contribute to science teaching.

Although comparatively new on the scene of education, industry's co-operation with science teaching has already brought great enrichment to the science classroom and has taken a rightful place as a significant aspect of science education. It has benefited industry and education both and has pointed the way to co-operation in other curriculum areas as well. To those who are active in this work, it is an encouraging fact that these two important aspects of American endeavor—industry and education—can work so harmoniously together toward common goals.

C. Improved Teaching Through the Use of Audio Aids

GERTRUDE G. BRODERICK

Miss Broderick begins her article with a brief statement of the role of audio-visual materials in modern education. Next she discusses teaching techniques which can well improve the effectiveness of audio-visual materials in the classroom. The remainder of the article emphasizes the use of broadcast programs and recorded teaching aids, with particular attention to preparatory and follow-up activities. The writer closes with valuable information concerning the availability of recorded programs and scripts for same.

AUDIO-VISUAL materials have had a place in schoolrooms and instructional techniques for scores of years; some were used in man's earliest efforts at instruction. Others, such as television, are so new as to be found in only a small number of schools. Scientific developments have greatly increased the number of kinds of teaching tools, and equipment is not so limited as it once was. The motion picture, slides, filmstrips, radio programs, and recordings have, when properly used, enhanced the educational process and learning itself.

Today the purpose of teaching, basically, is to arouse the pupil and to direct his behavior into channels which are desirable, such as the development of

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proper skills, useful habits, conceptual understandings, acceptable attitudes, personal appreciations, and critical mindedness. The philosophy of audio-visual education accepts this tenet and holds that audio-visual materials validate the principle.

Beginning with the pupil as the central figure in the school, audio-visual education emphasizes that the learning process is accelerated when he is placed in a situation which facilitates learning. The classroom, the materials, the tools of learning, and the teacher add to or subtract from the meanings acquired by the pupil. Although only partly understood at present, motivation is a powerful force in the learning process. Since audio-visual materials can motivate, they must not be overlooked in any scheme of modern education.

The teacher needs at his command all the tools of the trade if he is to be truly successful with any one of them. He will avoid the mistake of relying upon a single cure-all supposedly good for every situation. He will not try to teach history by book and lecture alone, any more than he will fall into the notion of teaching natural science by exclusive use of microscope and test tube. He will study the factors in each learning situation. He will know the capacities of his pupils and how their abilities and interests may be directed. Then, upon the sure foundation of a sound and comprehensive knowledge of the teaching problem in any instance, he will select methods, devices, and aids to learning which, in his best judgment, will give superior results. Thus he will be a professional worker with a full complement of skills and instruments rather than a rule-of-thumb operator who has faith only in two or three prescriptions because those are all he knows.

Each audio-visual teaching tool has its own specific utilization techniques, but there is general agreement that the following principles apply to all: (1) they should be integrated with the curriculum; (2) they should be pre-studied in advance of classroom use; (3) they should be discussed with the class before use; (4) there should be ideas for follow-up activities; and (5) results should be evaluated.

Time and space here will not permit detailed suggestions for utilizing each tool. Emphasis, therefore, is concentrated on suggestions for increasing the effectiveness of radio and recordings as aids to teaching.

In the hands of a skillful teacher, a broadcast can serve as the basis for a stimulating and memorable experience. It can arouse an interest, influence an attitude, or impart an emotional context to a group of facts. It can be all these things because the pupils are predisposed in favor of the loud speaker even before a sound issues from it. A large percentage of their after-school time is devoted, as numerous studies have established, to radio listening. They are ready to enjoy the program, and they expect to be interested.

But what precedes the broadcast and what follows it will determine the educational effectiveness of what they hear. They must be prepared for the program, usually by a class discussion which will enable them to correlate the con-

tent of the program with some aspect of the work they have been doing. Their listening should be given direction so that they will listen not only for pleasure, but also with an ear open to recognize valuable information. They may take notes or not—and some will “doodle” inevitably, just as they do at home. On the whole, everything that can be done to support their absorption and concentration, their wholehearted attention to what is coming from the loud speaker, should be encouraged.

This will include a quiet room in which to listen, a good receiver tuned to the correct station some minutes before the beginning of the actual broadcast. Once the radio is properly tuned and the class is ready to listen, then there is need for an attitude of interest and absorption on the part of the teacher herself, even as she quietly takes the notes she will need to lead the activity that follows the broadcast.

There can be little value in listening to a broadcast unless the experience becomes part of the pupil's life through his own response and activity. There are scores of suggested activities prior to listening to a program, but some of the most important are: (1) having pupils summarize what they know of the topic; (2) listing things the class wants to know about the topic; (3) looking at specimens, models, or articles related to the topic; and (4) studying the broadcast manual and attempting to carry out its suggestions.

During the broadcast, the teacher's role may include noting the pupils' reactions; listing unobtrusively on a side blackboard or on paper any difficulties in understanding revealed by puzzled faces or by questions; determining new aspects of discussion or new approaches to the subject which may occur to her; manifesting at all times an attitude of interest and enthusiasm.

Follow-up activities are an essential part of classroom listening. Post-broadcast treatment, while tremendously varied in nature depending on the subject, requires careful planning and an avoidance of repetition of the same technique or approach, week after week. If the follow-up period is used simply to test or drill the pupils on the facts they have acquired, enthusiasm is blunted and nothing new is contributed. Testing pupils on the subject matter of the broadcasts is not a recommended procedure. If, however, the broadcast is utilized as a stimulus for other class activities, and these in turn knit the radio program more closely into the basic course of study, a double purpose has been served.

The resourceful science teacher will find that dramatic radio programs offer wide opportunities for interrelating different subject areas. This technique not only enlivens her youngsters' interest but also rekindles her own enthusiasm. She might find, for example, that radio stories dramatizing the Greek mythological background of the constellations would provide stimulating highlights in an astronomy unit that correlated science and language arts.

Follow-up activities which have proved valuable to many teachers include:

1. Oral discussion, whether in simple classroom style or in simulated radio-forum technique, particularly after programs employing that format

2. Written resume by pupils of the meaning the broadcast has had for them and questions which it has raised in their minds
3. Taking excursions to places suggested by the broadcast
4. Creative manual activities, such as drawing and construction of models or places mentioned in the broadcast
5. Supplementary reading suggested by the program, to further pupil's insight into the subject matter
6. Writing original stories or poems based on the program or related areas
7. Writing "additional scripts" for the series, along the lines of those heard, and producing them in class
8. Making scrapbooks for the series, illustrated by both original drawings and magazine clippings
9. Dramatic interpretation of similar or related stories, either in the form of radio broadcasts or of classroom plays
10. Collecting items for a hobby show related to the broadcast
11. Organizing an assembly program on a subject related to the broadcast which will involve writing to guests, conducting interviews, *etc.*
12. Numerous other activities will suggest themselves as the teacher continues to use broadcasts in the classroom.

An important by-product of class listening is improvement of taste and development of discrimination. Pupils can be led gradually to listen more critically to the programs they hear at home. The teacher may well ask herself what observable influence radio—in school and out—is having on her pupils' lives, as well as on such types of classroom performance as reading, speaking ability and vocabulary, leisure time activities, work, and study.

What has been said of radio as an aid to teaching applies equally well to recordings. By using recordings, the teacher has the added advantage of being able to use them precisely when she needs them. For the high-school teacher, particularly, this resolves the conflict between the rigid class schedule, on the one hand, and the equally inflexible schedules of radio broadcasts on the other. Secondly, a teacher may pre-study their content, maturity level, and general suitability, thus insuring proper conditioning of her pupils for the utmost in listening experience. She likewise may plan carefully for the post-broadcast listening discussion period.

There was a time when suitable recorded materials were not easily obtainable for classroom use, but today that situation has notably improved. Perhaps one of the largest libraries of educational recordings in the country is to be found in the U. S. Office of Education, and operated in co-operation with the Federal Radio Education Committee (FREC). The current catalog and supplement lists about 400 recorded programs which are suitable for use in a wide range of subject areas. A few of them are available only through purchase, but the majority of them may be borrowed for periods of two weeks without expense except for the return postage. All are 16-inch discs requiring special playback equipment with a turntable speed of 33 $\frac{1}{3}$ r.p.m.

Program materials in script form are described in the catalog of more than 1,400 scripts which are available on loan to teachers, radio stations, and civic

organizations. Scripts, likewise, cover a wide range of subject areas and they may be borrowed without expense except for the return postage.

The Radio-TV Services of the U. S. Office of Education also assumes responsibility for keeping abreast of program materials as they are developed through the country and a list of sources of recorded materials is available on request. It is gratifying to note that a growing number of organizations is developing recordings particularly with a view to their suitability for classroom use. Another effort to facilitate the use of radio programs by the classroom teacher is to be found in the annotated list of selected network programs which is published quarterly throughout the school year by the Office and distributed upon request.

As more teachers acquire skills in radio programming and utilization, new and better programs designed to fit the curriculum are bound to be developed. We are, in fact, limited only by our ambitions and creativeness—our ingenuity and sincerity.

D. Science Education Through Radio

JOHN HENDERSON

RICHARD R. ARMACOST

In this article, Henderson and Armacost describe two series of radio programs through which the Purdue University Radio Station helps enrich high-school science education in the surrounding area. They also discuss the sorts of preparation which classrooms should make for school broadcasts and suggest ways in which the programs themselves can be planned and produced more effectively. The writers also propose the wide use of magnetic tape-recordings as a means of increasing the flexibility and value of using this form of audio aid to science education.

RADIO offers many possibilities for use in high-school science classes. Its greatest contribution probably lies in the presentation of science specialists who, otherwise, would not be available to most schools and communities. Specialists may be interviewed, present papers, or participate in panel discussions. In addition, programs may involve dramatizing great discoveries or highlights of science or covering special events such as science fairs and congresses. It has been noted time and again that science programs designed particularly for high-school pupils are also of interest to numerous out-of-school adults in a community. Thus, these people are informed about a phase of their school's educational program and, in addition, can learn subject matter and develop their own thinking without having to attend high-school classes. This obviously is a highly desirable situation which can help draw school and community closer together.

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Purdue University has developed two 15-minute weekly radio programs designed to help reinforce high-school science courses. These are *Agriculture School* and *Ask the Biologist*. The *Agriculture School* program is prepared to meet the needs of a specialized group of Indiana high-school youth, the vocational agriculture pupils. These broadcasts are based on questions submitted by pupil listeners. Each fall, cards are sent to all vocational agriculture teachers in the state, and selected questions are fitted into the themes of various programs. Specialists from the different fields of agriculture at the university edit, answer, and discuss these questions. Representative topics from past broadcasts include: Eggs for Profit; Producing Quality Milk; Storing Farm Machinery; Why Keep Farm Accounts? Safety First on the Farm; Taking the Farm Inventory; Keep Soil at Home; and others.

Ask the Biologist is the name of a series of programs for high-school biology pupils, which is also broadcast weekly throughout the school year. It consists mainly of question-answer sessions, interviews, and panel discussions centered around biology topics of interest to pupils and teachers. *Ask the Biologist* is sponsored by the Purdue University Department of Biological Sciences. Leading Purdue University scientists, outstanding high-school teachers and administrators, and high-school pupils with particular science aptitudes appear on the various programs. Representative programs from past broadcasts have been developed around such stimulating topics as: Why Study Biology? Insects; Project Work; Your Inheritance; Fish and Fishing; Biology as a Vocation; Gardening; Keeping the Mind Healthy; and others.

School broadcasts are meant to *supplement* teaching, not to *supplant* it nor to minimize the importance of the teacher in any way. This principle, of course, applies to all learning aids used both in and outside the classroom. Broadcasts can assist the teacher by presenting new and up-to-date information by experts. Many questions that do not appear in textbooks can be answered and discussed. Pupils can get a degree of personal satisfaction, too, by having their questions answered on a given program. Classroom use of broadcasts provides a change of activity which is important in effective learning situations. In general, it can be shown that both pupils and teachers are encouraged to think more about various aspects of science. Furthermore, radio is a very economical method of assisting education when one considers the ratio of cost of broadcasters' time to the number of listeners involved.

Using radio programs in the classroom requires some types of special preparation. For example, it has been found that pupils receive much greater value from a broadcast if they have been thoroughly prepared for it ahead of time. An outline of the year's radio programs should be in the hands of the teacher at the start of the year's work. This can allow him to plan for the broadcasts and carefully fit them into his course of study. It should be emphasized, however, that despite the orientation and directive aspects of an outline, manual, or any teaching aid, the ultimate use of a broadcast should be determined by the teacher

with his specific group of pupils in mind. No other authority can dictate the use of a broadcast for a specific school.

A school broadcast should have the same general excellence of presentation as that used in any good radio program. Its effectiveness in classrooms will depend to a great extent on the approach used by the moderator, or narrator, and his skill in guiding the participants to share information with pupils of a given grade range. The classroom teacher can help by preparing the class properly, writing terms on the board during broadcasts, pointing things out on charts, sketching, and, finally, summarizing and discussing material presented. It would be wasted effort if a science broadcast did nothing more than merely add to the great mass of facts in a specific area, or only repeat known facts printed in textbooks. A broadcast should stimulate in a unique way. Ideally, it should present something that cannot be gotten in any other way, or at least present something that can best be done by radio. The teacher and administrator must look upon science broadcasts as definite aids to learning. They are not solely for entertainment, although entertainment may be a secondary feature. It is hoped they will be enjoyable.

Purdue University has found one sure way to relate the science program to class needs. The person in charge of co-ordinating broadcasts for a particular group is constantly in touch with the high schools over the state. Many times he is present in the classroom when a previously recorded program is broadcasted. He can then personally judge the effectiveness of a program and study the teachers' use of this type of audio-education. This way he can help individual teachers by making suggestions, as well as correct errors of his own planning. In addition, he may note and pass on ways by which guests of a program series may improve their presentations.

Since all prospective high-school listeners cannot listen to a radio program at any one time, the best policy is to provide tape recordings of the productions and make them available to high schools. The provision of these tapes also permits broadcasts to be fitted into various science courses in different schools, which usually will differ, somewhat, one from the other. Many high schools have their own tape recording and reproducing machines and then can make use of the programs when they desire. Tape libraries can be developed in high schools and used from year to year. Broadcasting stations can maintain tape libraries as a service to the high schools. It has been found that the tape recorder is a very useful instrument for many phases of high-school learning and teaching. In the near future, in our opinion, schools will have tape recorders as a standard piece of educational equipment.

Science subjects, probably more than others, need the stimulation that can come by showing relationships and applications in any given area. These may have a setting far removed from the school laboratory, or they may be within the immediate experiences of the pupils themselves. Of course, the radio program cannot teach, in the true sense. But it can add to the experiences with which

pupils educate themselves. Such an instructional practice tends to embrace that approach to learning represented by the statement of a great writer, "Don't flatter yourself with teaching a great number of details; put spark to the spirit, and people will catch fire where they are inflammable." The use of radio in the school cannot displace the teacher. Radio programs, properly used, are to reinforce, complement, and strengthen the teacher's efforts. The introduction into the classroom of new horizons or extra-mural entities of any sort should be planned and controlled. Otherwise, it becomes adulteration. A whole plethora of science facts and stories are entering the minds of high-school pupils, largely through the mass media, outside the school.

We are at the beginning of a great communications revolution. Whether we like it or not, the mass media will continue to inform, stimulate, and influence the development of attitudes in young people, beyond the purview and control of the teacher. As one educator put it: "Today's student is practically surrounded by a sonic barrier through which the thin voice of the teacher cannot penetrate unless he uses the same modern means which tend to distract him from his work. . . . If our teachers intend to reach their pupils . . . they will have to use the tools of our times." Radio is one of these tools, and television is fast becoming another.

E. Science Education Through Television

BENJAMIN DRAPER

Mr. Draper opens his article with a discussion of the advantages and disadvantages of television as an educational medium in general, both in and out of school systems. He follows this with a section aimed specifically at science teaching through television, a section in which he points out and supports the semi-serious contention that "television might well have been invented specifically for the teaching of science." The writer closes his article with a statement of his belief that educators can best make their influence on this new communication medium felt by exploring it and using it to their best advantage, both in the form of specially prepared school telecasts and in the form of commercially available programs.

Potentials

TELEVISION AS A TEACHING TOOL

TELEVISION, wisely handled, can be a very effective tool both to direct teaching and to provide wider background materials than presently available in classrooms. From the school administrator's viewpoint, its chief advantages will lie in the realms of uniformity, efficiency, and quality or specialization. As a

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teaching tool within the classroom, it offers a great many possibilities. In the present excitement stage when educational television is almost a fad, some of these possibilities are not always apparent nor are they all as yet discovered. School administrators should accept the challenge of television—studying, gaining experience, and learning to get the maximum from the new medium of communication.

In its essence, television is only that—a medium of communication—just as much as printing, the telephone, or radio. Like these, it has its own set of advantages and disadvantages. It surpasses other media in that it can transmit both sound and sight as it happens. Television cannot do the entire job of communication to the exclusion of these other media. It is neither as portable as a book or newspaper nor is it as permanent. It is unnecessarily complicated for the place the telephone and telegraph fill. Although it hasn't reached the "two-way TV wristwatch" stage already achieved in the comics, it does appear, within economic limitations, that television is replacing radio. It is competing in the entertainment field, not only with radio but also with motion pictures, and, as it finds its way into the school system, it will replace or at least supplement these media.

The first and perhaps greatest advantage which a teaching telecast has, as it is beamed from a central location to several or many viewing groups in a school system, is that of uniformity. Television, as well as textbooks, courses of study, teaching outlines, and audio-visual aids, has uniformity as one of its primary aims. A telecast offers this same advantage and a good many others which the other, more limited media lack. To gain the most effective use of television in direct teaching, the school administrator must first examine the questions "What can television do better than other teaching tools?" and "What can television do that other teaching tools cannot do?"

Needless to say, any plan of central or standard teaching aids, prepared by specialists and used by many teachers, other things being equal, should offer the advantage of quality of specialists' work over the accomplishments of individual teachers who have other principal objectives and whose energies are otherwise occupied. The limitations of such tools arise from the adequacy or completeness of the materials supplied and the capabilities of teachers to use or supplement them. A teaching telecast, it can be argued, goes a long way towards obviating the latter.

Not only can experts be utilized in preparation of materials for telecasting but also a vast amount of research that could not possibly be done by individual teachers can be put into the preparation of a telecast on a specific subject. Similarly, more expert presentation of materials is possible with trained television personnel. Some staff members will televise well and others will not. Demonstration materials, which, because of space, expense, or other limitations, could not possibly be sent to individual schools, can be used by telecasting from a central location.

The variety of teaching materials which are available to the classroom on television is endless, greater perhaps than with any other visual, audio-visual, or other teaching aids combined. Television can use films as well as "live" or studio demonstrations. There is no reason that presently existing film libraries cannot be utilized very effectively in telecasting to the schoolroom at a tremendous savings in the cost of multiple prints of each film subject now necessary.

Curriculum materials are constantly in need of grading, slanting to specific age levels, and revision in the light of experience. This procedure can be done easily and effectively with television teaching materials. The live telecast done from a script can be revised as it is repeated much easier and certainly much cheaper than printed materials or films can be corrected, changed, or otherwise reworked.

There is no doubt but that one of the fundamental appeals of television over other forms of both communication and entertainment is its immediacy. A "live show" on television, seeing something happen right now, has greater appeal than filmed television programs. This appeal, as an attention-holding device in the classroom, if nothing else, should not be minimized. It constitutes a principal competitive advantage of television over motion pictures, radio, record players, tape recordings, and other teaching aids in the classroom.

The potential financial savings through teaching by television is being argued *pro* and *con* in the broader areas of educational channel discussion. Without presuming to enter that fracas, it can assuredly be stated that for specific teaching jobs for which television is eminently suited, it can do them cheaper and better and more materials can be utilized than with ordinary classroom staff and facilities. Disregarding for the moment arguments of expense, a single telecast can reach every classroom in the system with a live, timely message—an accomplishment that was impossible before the advent of television.

Limitations

Not all the results of teaching by television will be evaluated as being as satisfactory as those obtained by other means and with other devices. None but the most pure blind pupil would wish the TV set to replace the teacher! Some thought, however, should be given to the limitations of television as a teaching tool. It is not an unbounded benefaction. A good case can be made against it in that it takes time from classroom teaching which is still the most effective educational process. Over and beyond the time classroom viewing will subtract from this essential learning process, it has other disadvantages.

There is no doubt but that there is a serious attention lag in classrooms during the showing of motion pictures, the playing of records, and use of radio and other audio-visual devices. This same attention lag cannot help but be present in the utilization of a television set, perhaps even more so, since the problem of getting a good view of the TV screen will be greater than with motion pictures—at least until the day when technical advances will have made wall-sized TV screens possible and economically feasible.

In the matter of audience participation, radio has perhaps the greatest opportunity in that the listener creates for himself in his imagination the picture he hears described. Television, at the outset, destroys this opportunity by letting the viewer see what he is listening to and thus rendering him passive where in the case of radio he was, of necessity, active, to a greater or lesser degree depending of course on program content and the individual. One of the first production problems of the television industry is to devise ways of stimulating the viewer and encouraging him to participate with his mental processes.

It has already been argued that immediacy is a great advantage of live television over motion pictures in the classroom. The teacher, however, will doubtless argue that in the case of movies, they can be shown at will, at the proper point as determined by other activities and progress within the individual classroom. This flexibility gives a mechanical advantage not to be disregarded. It may constitute a major administrative problem to arrange schedules to conform with system-wide telecasts.

Not only will it be impossible for every pupil in a specific grade to be studying the same subject at the same hour of the day, but it will also be impossible for all classes in the system to be ready in their progress for a new step to be introduced *via* a telecast on the same day. The time of day of telecasts, until schedules are rigidly uniform, will plague both pupils and teachers, not to mention the problems thus created for administrators. These situations are not here outlined as arguments against the use of television but are advanced to stimulate administrators to give thought to the inevitable problems TV teaching will present. Until satisfactory solutions are found, the losses may go a long way towards offsetting any possible gains in the minds of both teachers and pupils who find real learning processes interrupted for telecasts.

No teaching tool is all-effective in every situation. There are some parts of the instruction program that of necessity must and will continue to be done by direct classroom teaching. Others are better suited to radio, films, and other methods and devices. It will take a long period of experimentation, of trial and error, and an extensive background of experience to discover the most effective uses of television for schoolroom use.

TEACHING SCIENCE BY TELEVISION

Problems and Methods

It is not an entirely facetious observation that television might well have been invented specifically for the teaching of science. Certainly it can do that particular job better and more effectively than many other things attempted with the media. It is admirably suited to "show how" things are done. One top advantage of television is its ability to use the close-up effectively and to magnify for the viewer objects the TV camera is focused upon. The added intimacy of the television medium in bringing the subject and the people who present it directly into the living room of the viewer is an advantage that is important.

Wherever possible, this should be retained in classroom presentations. The pupils should have the feeling, as he watches a laboratory demonstration on television, that he is the only other person sharing the demonstration with the demonstrator. Television should not be used as a lecture platform.

Direct teaching by television has proven extremely effective for several years in the field of medicine. In 1947, Johns Hopkins Medical School, co-operating with RCA, pioneered in the use of television to teach medical and surgical techniques. Since that time demonstration crews have worked throughout this country, in five Latin American countries, and in Europe.

A television camera, suspended over an operating table, can not only follow with precision and accuracy, but it also has the power to magnify what it records. Literally hundreds of pupils can get a closer and even better view of the surgeon's work by watching a TV screen than the half dozen who were nearest the table in the old amphitheater method of teaching. The installation and use of television equipment in medical schools is already an accomplished fact in several institutions. Telecasting is, of course, done over closed circuits and is not available to the general public.

It is not argued that surgical procedures should be made available to the public schools, rather this use of TV is cited as an example of the possibilities of improving the quality of teaching. Both biological and other science laboratory procedures could well be demonstrated to classes on television. Similarly, dangerous experiments such as those in the field of atomic energy, complex ones that require extensive equipment, and demonstrations from relatively inaccessible places can be brought into the classroom.

At the present time among the programs on commercial channels with wide viewing appeal are the "how" shows—those that enlist viewer participation by teaching how to bake a cake, arrange a flower display, or sew a dress. Some science teaching, with advance planning and distribution of materials, can be accomplished by a telecast which directly asks pupils in the classroom to perform certain steps, to answer questions, to fill in blanks, or otherwise participate as they watch and listen to the TV set. The obvious limitations to such activity are that each pupil is equipped with only one pair of hands and one pair of eyes. Although he can do as he listens, it is not always possible to *do*, to *listen*, and to *look* all at the same time.

In the Classroom

The use of television will enable the school system to bring to its pupils guest scientists of eminence and importance in an intimate way, in a manner and relationship and with a message and lesson that would be difficult to achieve with any other media. In a city-wide telecast, it is possible for a school administrator to persuade top men in various science fields to demonstrate their work over the school television system. Such a series of telecasts would offer entirely new opportunities of enriching the science curriculum.

While there is no substitute for doing, direct television teaching can provide initial materials or information for subsequent classroom and laboratory work. It can carry part of the load and perhaps in the long run effect an economy of time especially in courses where lectures followed by laboratory work are a standard procedure. It can certainly add variety and extend horizons beyond ordinary classroom limits.

Television is peculiarly suited to biology courses where live animals are used. Without minimizing the gains of having pupils handle live animals, it does not take much imagination to supply a dozen examples where economy, safety, expense, and nuisance problems would be minimized by bringing some of the live animal segments of the biology curriculum to the classroom *via* television. Not one science teacher in ten thousand could or would want personally to extract the venom from a rattlesnake in front of a class. Yet this demonstration, performed by a snake expert, has been done on television with dramatic and attention-holding results. Viewers were glued to their chairs for the balance of a highly educational program on snakes.

By attaching a prism to the eye-piece of a microscope, it is possible to focus a television camera into the instrument and to give the television viewers an actual look through a microscope. As a matter of fact, the viewer gets an even larger and more detailed picture since the TV camera in turn magnifies and enlarges the field of vision that would ordinarily been seen through the microscope alone.

Microscope programs on television have proven extremely effective in teaching. They certainly hold attention. A minimum of arithmetic is necessary to reach the conclusion that this method of looking through a microscope on a city-wide scale is infinitely cheaper than to provide even one instrument to each classroom. The argument that the pupil is deprived of the chance to learn to use the instrument himself can be met to a degree by demonstrating how to use the microscope as a part of the telecast.

A well-planned science television program can use a variety of materials to tell its story—demonstrations, live animals and plants, filmstrips, remote location sequences, maps, charts, specimens, mechanized and three dimensional models—and, it can use them all in rapid succession to put together a story. Teachers or demonstrators who are chosen for their ability to present the subject effectively and interestingly and for their television appearance and personality will add much to the quality of the telecast. It is not a simple matter to put together a coherent, interesting, and useful TV program that pupils will want to watch but it is being done and such programs are finding their way into regular classroom use in several school systems. They are perhaps more effective in the field of science than in other subjects.

For Background Materials

Without arguing the merits or problems of educational and commercial channels either competing or supplementing each other in television, it would

not appear inconsistent for school administrators to incorporate into the curriculum not all but some of the output of commercial channels. Not the least advantage to accrue from such use would be a strengthening of the school-home tie and perhaps a heightening of parents' interest in the school. Such an integration would do much to stimulate good viewing on commercial channels where the problem presumably exists. Where educational telecasting facilities are limited or non-existent, even wider use can be made of commercial programs although those programs may not be arranged or produced in the specific manner the educator would like, the content in these cases being the important consideration.

There are presently upwards of a dozen good science programs seen on commercial networks and many more on local stations. These can be used both as background materials and as a stimulus to pupil interest. Several of the producers of these programs make available to school systems, well in advance, a list of the subjects and in some cases, copies of the scripts. With this material at hand prior to the telecast, teachers are able to provide pupils with background materials, to stimulate further study, and, after the telecast, to conduct *post-mortems* or question-and-answer periods.

In addition to direct classroom teaching by television, administrators will want to canvass thoroughly the area of background materials that can be provided best *via* television. It might well be predicted that this phase of the use of TV in the classroom will eventually emerge as being of major importance. Certainly at the beginning of a semester or at intervals in any given segment of the course of study where the day and hour time-table is system-wide, one or more telecasts can be utilized to provide introductory and background materials.

At announced intervals telecasts can be utilized especially if such times are at the beginning, not in the middle or at the end of a class period, a unit of study, or a school day. The content of these background programs, like supplementary reading lists, should minimize duplication of materials in the course of study. They should be geared to provide more and additional kinds of information and material, new stimuli, and new horizons. Such programs, carefully planned and executed, can infinitely widen educational possibilities.

Dozens of supplementary science subjects which administrators have long wanted to include in the curriculum are now possible with the advent of television—careers, distinguished scientists, industrial stories, laboratories, travel, field work, and subjects too complex or expensive for individual classrooms.

Whether parents, pupils, or school administrators will or not, television is here to stay. It will in the next decade have had a profound influence on our lives, doing perhaps fifty per cent of the educating, in the broader sense of the word, of succeeding generations. School administrators will want to make their influence and leadership felt in the use of television for the good. In utilizing it as a teaching tool, integrating it with the school curriculum, they will very probably exert more influence in this direction than is presently indicated.

F. Opportunities for Pupils with Unusual Science Talent

HERBERT S. ZIM

In this article, Professor Zim briefly outlines the need for the encouragement of science-talented youngsters and discusses the kinds of behavior which help teachers identify such gifted individuals. Most of the article is devoted to descriptions of school activities which can help locate and encourage youngsters with unusual ability in science. These numerous suggestions are grouped as: enriched activities in the classroom, assistance in the school science program, school service, community service, club activities, summer activities, contact with professional work in science, individual money-earning projects, contests and scholarships, and guidance.

THE role of science in general education has been clearly laid out. It is the major function of science in the secondary school. At the same time, and within the framework of general education, the teacher cannot ignore the complicating problem of the pupil who sees himself headed for an occupational and often professional role in science. These pupils form a distinct and very important minority group. The size of this group is not easy to estimate. Some have considered the well of potential talent for science and engineering as about fifteen per cent of the total high-school freshman class. Others think five per cent is closer to the facts. My own estimate of the number of "science interested pupils" in the junior high schools of the metropolitan New York region was about five per cent of the boys and two per cent of the girls. Occupational statistics do not clarify the problem. We do not know how many young people of talent and ability are lost along the route for economic, personal, and other reasons.

Whatever the size of this group of potential scientists, the group is one of critical importance. Studies and opinions have emphasized the critical place of science in our technological culture, and of the need of maintaining a steady and probably an increasing supply of technically trained men and women. As industry and commerce become more and more mechanized, the human labor needed in its operation becomes more and more skilled and technical. The ratio of engineers and scientists to other workers in industry has constantly increased.

The recognition that a pre-engineering, pre-scientist group exists in the high school raises a number of educational problems. How do we provide for individual differences in a mass education program? Are work experiences worth while for talented adolescents? How can we give the better pupils *experience with science* instead of *courses about science*? These and many other problems have not been studied well enough to provide even suggestive solutions. The best we can do at this stage is offer opinion, substantiated by personal observations, as to the best educational program for such gifted young people.

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The clarification of such terms as "science interest" and "science talent" has a first demand in science education research. The nature of science talent is not at all clear. Preliminary investigations suggest the problem is complex. A number of factors can be counted upon in the recognition of science interest or talent. Based on these characteristics, the identification of young people who are potential scientists is not difficult. Briefly, the best evidence is continued creative activity in science. Teachers can easily recognize such activity which can be accepted as *prima facie* evidence of interest. The boys or girls who are constantly making collections, doing experiments, helping in the laboratory, visiting museums, reading scientific books, or making themselves conspicuous by their contributions in classes or clubs are the ones whom the science teacher should watch.

This interest can usually be recognized before the high-school level if the educational environment is one that gives the pupil time for voluntary science activity in elementary or junior high school. This in itself tends to favor pupils attending larger, better equipped elementary schools and those with a more permissive program. It tends to screen out pupils of equal capability who, because of a restricted educational environment, do not have the opportunity to nurture their early interests and talent.

Science interests can generally be recognized even more clearly at the junior high-school level so that the teacher who provides opportunities over and above routine class assignments has the rare privilege of being the first to identify the promising scientist. This teacher can contribute definitely towards the pupil's growth as a future professional worker as well as towards his basic general education.

The secondary school has a unique advantage in this direction. While interest in science is sometimes evidenced as low as the age of six, seven, or eight, it does not begin to crystallize into definite functional "talent" until several years later. This may be due to a lag in developing sufficient skill in reading, handwork, and science to enable the young person to go ahead on his own and achieve success in the things he tries to do. The early high-school years are important ones in the fixation of these interests and in channeling them into accepted educational and vocational patterns.

A major opportunity for guidance exists in the secondary schools. It is essential that guidance people and science teachers be aware of the total educational picture in which the boy or girl who is interested in science is involved. Guidance must consist of more than providing opportunities for taking more courses or for doing extra readings or experiments. A pupil whose interest in science is of several years' standing by high-school age is usually involved in activities which are important enough to him to play a definite role in his developing personality.

This guidance of talented pupils needs further study, but even such a simple factor as the time these pupils spend on their experiments and hobbies indicates they cannot be treated lightly. The science-interested pupil, whose voluntary

work in microscopy, chemistry, radio, or geology occupies much of his free time, may cut himself off socially from his age group and not receive the maximum educational advantages that the school can offer. Guidance must take into account social, emotional, and intellectual growth of the potential scientist. It must consider him as a person as well as a potential technician.

With these considerations in mind, it is possible to suggest opportunities for secondary-school pupils who have unusual interest or talent in science. The resources of the school and the community, varying as they do from place to place, means that the science teacher must select or develop opportunities which fit his particular circumstances. But even in the smallest rural school there are possibilities for enriching the programs of pupils with special ability and fostering their interests and talent. It goes without saying that the age of the pupils, his particular interests and his school adjustment, must be considered. The boy who is so interested in science, that he doesn't care what progress he makes in English or history, needs different opportunities than the pupil who has a more balanced academic viewpoint.

The teacher who wishes to take advantage of these ways of enriching the science education program must know both his pupils and his community. He may have to create opportunities for his pupils as well as discovering those which already exist. The following list, divided into arbitrary and overlapping categories, suggest what opportunities the teacher may discover or devise—rather than how he should take advantage of them. Note that some opportunities may normally be a part of the class science program and will benefit the class as a whole in addition to the more interested pupils who actively participate. Other opportunities take the interested or talented pupils out of the class, and often outside the school. In these cases, the science teacher will want to follow up and be sure outside opportunities do the educational job that was anticipated when they were presented to the pupil.

ENRICHED ACTIVITIES IN THE CLASSROOM

This is an obvious place to begin with pupils who have more than average interest and ability in science. They can be directed into more intensive activities or to a wider range of activities than other pupils. Specific suggestions include the following:

1. *Reading reports* on specific topics of interest to pupils. These may be correlated with local industries or resources; *i.e.*, the manufacture of glass, the development of hybrid corn, the state wildlife conservation program, lives of famous scientists, *etc.*
2. *Classroom or laboratory demonstrations* of reactions, processes, or theories to supplement usual discussions and laboratory work. This may involve building of models. Pupil demonstrations are always popular when well done.
3. *Extra experiments.* Many teachers permit advanced pupils to do extra experiments selected from other textbooks or to do other "honors" work.

4. *Preparation of charts and diagrams* as flow charts of industrial processes; breeding or hybridizing data; application of laws of falling bodies to parachute jumps, etc. Such material can form the basis of a permanent teaching collection.

5. *Pupil projects.* These involve more than the preceding items, though reading, making charts, and the like are often an integral part of a project. A project is a unified attack on a limited area of science for enriched experience. It may or may not include experimental work. It does involve using all pertinent sources of information in the school and community.

6. *Experiments and research:* It has been clearly demonstrated that senior high-school pupils are capable of initiating and carrying through simple research problems. These are different from a project which emphasizes exploring, summarizing, and digesting information in a particular scientific field. Research involves discovery of new facts through observational or experimental techniques. Pupils need guidance in setting up an experiment; in recognizing factors which may be involved, and in interpreting their findings. With help, a pupil can, after becoming familiar with the literature on a specific problem, tackle some small phase of it and perhaps come out with reliable data. Individual or group research is probably the richest type of experience for pupils with unusual talent in science. It goes without saying that an unusual teacher is needed to channel and guide such work.

ASSISTANCE IN THE SCHOOL SCIENCE PROGRAM

It is of undisputed educational value to talented pupils and of real practical value to the school when these pupils are permitted to assist the teacher in the laboratory and classroom. There are a number of ways in which this can be done.

1. *Laboratory squads* are organized to prepare and get out materials for science laboratory work or to set up apparatus that the teachers will need. Members of the squad also keep supply inventories, prepare stock solutions, clean microscopes, care for laboratory animals, wash glassware, and do numerous other routine jobs. All this frees the teacher to do more constructive, educational work, or at least relieves some of the heavy overload most science teachers carry.

2. *Assistance with younger pupils:* In a number of cases, talented high-school pupils have been used to assist in the elementary science program in nearby elementary schools. One such pupil ran a small beginner's club, another helped fifth-grade boys make simple radio sets. The elementary-school classroom teacher is rarely prepared to do specialized work in science and is thus likely to welcome and make good use of specifically interested and trained high-school pupils.

3. *Slide collections:* High-school biology pupils have prepared microscope slides of plant and animal tissues on a large enough scale to supply much of the material needed for class use in biology. Some histological techniques are simple enough so that pupils can produce useable slides. This can be a definite financial contribution to the school's limited science budget.

4. *Culture center:* High-school biology pupils have set up a center for the culture, propagation, and distribution of live plant and animal materials to their own and other high schools. They have raised amoeba, paramecia, hydra, and other invertebrates. They have also kept stock supplies of white rats and mice for diet experiments. Cultures of bacteria and mold have been maintained as well as live mosses, ferns, and flowering plants. This work can be valuable in promoting firsthand science experiences. Many schools actually improve their science teaching because of the intensive help of a talented group.

5. *School museum:* Science talented pupils have often started or have taken over the care of a science museum in the school—identifying, labeling specimens, preparing an "exhibit of the week," keeping material clean and up-to-date. Teachers of biology and earth science often use museum material as an integral part of their work. The wider use of school museums to bring science to the entire school population is worth more attention. Talented pupils may make a real contribution here.

6. *Libraries of books and free and low-cost materials:* Pupils may be put in charge of assembling a collection of free and low-cost materials for classroom use, for filing these materials, and for taking charge of pupil loans, if they are so used. If the science library is housed in the science department, as it often successfully is, pupils may be put in charge of this also.

SCHOOL SERVICE

Besides assisting within the science department, science talented pupils can use their skills in ways that will benefit the school as a whole. The possibilities will vary but tend to be stronger in the field of physical science than biological science.

1. *Visual aids:* Responsibility for care of, setting up, and using sound and slide projectors, etc. Pupils can be responsible for simple maintenance of equipment, storage, and distribution of film and slides.

2. *Radio and electronic devices:* Pupils may be put in charge of the school radios, electronic equipment such as wire or tape recorders, or the school public address system. In a number of cases, pupils have built a satisfactory public address system for the school auditorium, athletic field, or for other school use.

3. *Plants for the classroom:* Individual teachers may not take the initiative in providing growing plants to beautify their classrooms, but, if these are provided by pupils who are interested in raising plants, they are likely to be received and appreciated. Occasional pupil check on the condition of potted plants is a good thing.

4. *Assisting the school nurse* in filing cards and records and doing other routine jobs. Often because of limited time, parts of the health records of students are incomplete. Pupil assistants can gather a good deal of the needed health information for such records. They can check up on dates of vaccinations and inoculations, on dental visits, or tabulate records on school absences in relation to health.

5. *Assisting in school maintenance and repair:* While not closely related to science, this is important in smaller schools. It is justified because many boys of scientific bent are also skilled in the use of hand and machine tools. Often small repairs, putting up a shelf, or doing similar minor jobs are delayed because the custodian cannot fit them into his tight schedule. Such jobs cleared through the appropriate administrator can often be done satisfactorily by pupils.

6. *School photography:* Pupils often develop sufficient skill with the camera to take pictures of pupil activities and others worth having for school records or for publication. Photographic records of science experiments or projects are valuable for the development of the science program.

COMMUNITY SERVICE

Extending the horizons even further, there are a number of ways in which science talented pupils can serve the community through the school. Here are a few examples.

1. *Soil testing:* Pupils have set up a center for simple soil testing, giving home gardeners advice on improving their soil. This was first done during the Victory Garden period, but it is equally valuable nowadays.

2. *Surveys of local trees or other plant resources:* Such surveys, mapping the town, showing the location, kind, and number of trees turns up trees of local interest which should be preserved. It helps to give a concrete picture of local natural resources which the town may want to preserve or improve.

3. *Conservation projects:* Conservation projects by the school in which talented pupils usually take a lead can demonstrate good land, plant, animal, and water conservation practices to the community. In rural areas where this is of particular importance, help can be secured from the county agent, soil conservation agent, or teachers of agriculture.

4. *Health campaigns:* Pupils can aid in disseminating information about cancer, heart disease, or in other health campaigns. Pupils have even worked in a diabetes campaign, doing simple urine examinations for sugar for the school or the entire community.

5. *Civilian defense:* In civilian defense planning, detailed knowledge of community resources is essential. In smaller towns, talented pupils may gather data on housing, water resources, medical help, etc. Such surveys, made under the guidance of a competent official, can be of value in promoting good community relations as well as in doing an important job.

The activities so far suggested for pupils with unusual science talent move from enriched classroom programs to a series of service activities which take pupils from the classroom into the school and the community. The value of service activities cannot be over-emphasized. They represent a real job. In them, the pupil sees direct, closely related application of what he has learned and what he can do. The educational values become broadened as the pupil, in a limited way, applies his skill and knowledge to a life situation. It is not going too far

to urge that every pupil with an interest in science should have some opportunity to perform services through that interest before he has finished his secondary education.

CLUB ACTIVITIES

In most secondary schools, club activities are a recognized part of secondary-science education. Recent evidence has indicated that even in small secondary schools where there is only one science teacher, club activities are not only possible but may also be very useful in supplementing and enriching classroom work. Clubs which provide opportunity for experiments, demonstrations, and other firsthand science work are to be highly desired. The possibilities include the following:

1. *School science clubs* such as biology club, chemistry club, bird club, camera club, and the like. These, of course, need the sponsorship of the science teacher or some other competent adult, though talented pupils can and should undertake the major responsibilities for activities.

2. *Local science clubs*: In many communities, organizations of amateurs work in scientific fields. Local Audubon Clubs bring together people interested in bird study. There are amateur organizations in the field of astronomy, mineralogy and geology, plant life, and many other areas of natural and physical science. Older high-school pupils with an interest in science will usually be welcome at meetings and field trips of such organizations. They can gain a great deal from such out-of-school contacts with people who have similar interests.

3. *Junior Academies of Science and Science Clubs of America*: These offer another channel for science talented pupils. Affiliation of school clubs with Junior Academies of Science or with Science Clubs of America offers additional possibilities to participate in wider activities. Junior Academies of Science often have regional or state-wide meetings at which potential scientists can meet and share experiences.

SUMMER ACTIVITIES

The science talented young person should be encouraged to continue his interest and activities during the summer months. There is a real possibility that work done during this period may have greater educational value than the courses taken during the school year. Among the possibilities for summertime activities, in addition to individual projects and studies as indicated above under the section, "Enriched Activities in the Classroom," are the following:

1. *Science camps*: A few camps have been set up specifically for science talented or science interested young people. Here the young person can enjoy a summer vacation plus the additional opportunity to work intensively in a significant area of science. Field and laboratory work are, of course, emphasized in these places, where the staff includes science specialists.

2. *Work camps*: Work camps are not a specific activity in the field of science. They have been organized under the auspices of such groups as the American

Friends Service Committee to give young people a opportunity to work in areas where they can make a definite contribution to some social need, as in our South West, Mexico, and parts of Europe. The work involves manual labor correlated with social contacts and exploration of the region in an attempt to understand the people and the problems. A work-camp experience can be significant in helping the science talented boy or girl recognize some of the impacts of science on society through firsthand learning in areas where this impact has been limited.

3. *Occupational work in science:* Job possibilities are open to many science interested young people. Even of more value than the remuneration is the opportunity for a realistic appraisal of science in action as seen in an actual laboratory. A number of large corporations, hospitals, and other institutions go out of their way to provide work opportunities for science talented young people, so that they can get an early professional taste of science in the area of their interest. In addition to this type of work involving laboratory and field experience, there are opportunities to assist in nature study work at summer camps.

4. *Travel:* Since science education on the secondary level is essentially general education even for those who feel themselves destined for professional science work, travel can be exceedingly important. This need not involve great expense. Family trips or those involving a small group of trustworthy pupils can cover a good deal of territory and see a great deal at relatively low cost by camping out and using facilities in national and state parks.

CONTACT WITH PROFESSIONAL WORK IN SCIENCE

As already implied, activities that give the science talented young person some contact with professional science work are very important, especially in the senior year in high school. A few other possibilities in this direction are worth noting.

1. *Personal contact with experts* either informally or as part of vocational guidance is desirable. An hour or so conversation with a forester, doctor, electrical engineer, or the like may be very significant to the young person who has chosen such a professional career. Once contacts are made, they are likely to be longer than a single meeting and have a lasting advantage for the pupil.

2. *Attendance at scientific meetings:* In addition to club activities, it is often possible for pupils in larger cities to attend meetings such as those of the American Association for the Advancement of Science and of other scientific groups where the annual meetings are rotated from city to city. Pupils may usually attend the lectures and discussions or visit the exhibits.

INDIVIDUAL MONEY-EARNING PROJECTS

The skills that many pupils develop in their science interest can be put to practical use in earning money. Care should be taken in encouraging this as the attractiveness of earning money may sometimes give a shortsighted feeling of

immediate success, and minimize the pupil's feeling that he is just beginning in terms of long-range goals. Some possibilities for pupils include the following:

1. *Photography*: This hobby can be developed to a semi-professional level for either school work or for taking pictures within the community.

2. *Collecting biological materials*: Biological supply houses often need fresh and preserved materials. Pupils who have become familiar with a specific area of biology and who have had considerable field experience can earn money collecting and preserving specimens. There is also the possibility of marketing prepared microscope slides, if the pupil has unusual skill or unusual materials.

3. *Repair services*: Many pupils working in science are handy with tools. Possibilities for work in radio repair, sharpening of tools, and other similar activities should be noted and perhaps used.

4. *Inventions*: There are cases of secondary-school pupils patenting inventions before they have finished their high-school work. Pupils should be urged to work creatively in the area of their interests and should be encouraged to invent and experiment even though the possibilities of reaching something that is patentable and profitable are very small.

CONTESTS AND SCHOLARSHIPS

Since interest in science first develops at the elementary and junior high-school level, contests held late in the secondary school do not *discover* science talent. To a very small group of pupils with very unusual talent, they offer an opportunity reward. Attention of pupils should be called to such contests. On the other hand, the activities already mentioned are likely to contribute more towards the education and development of most science talented young people than participation in any single contest. In addition to the Science Talent Search, there are a number of other state and local contests, many covering broader areas than science, in which science talented pupils have a good opportunity to win, largely because they tend to be people of a high intelligence and other characteristics of academic success.

GUIDANCE

No function of the school in relationship to its more able pupils can be more important than the role of guidance. Essentially, all the activities and opportunities so far listed must be part of a guidance program. The list itself can have very little meaning unless some member of the faculty is actively participating in guiding and working with the talented pupil. Guidance should not only involve the selection of science courses, but it should also consider the broad educational problems that a science talented pupil has, perhaps even more than a pupil without such an intense interest.

When a science talented young person has the confidence and backing of a teacher or other professional person whom he admires, this relationship goes far in assuring the young person's successful entry into further scientific study

and into professional work in science. It is through continued guidance that the activities herein suggested can have most meaning for both the pupil and for the school.

G. Science Fairs—Science Education in the Community

NORMAN R. D. JONES

In this article, Mr. Jones discusses two kinds of learning activities which can greatly broaden the scope of science education. The first of these is the science fair, which he describes as an extensive project involving an entire community. The writer also describes the organization and operation of a summer course for high-school pupils based largely on field trips and camping experiences centered around points of scientific interest in the community. A plan for a county-wide science fair is included at the end of the article.

IN recent years, with an ever-increasing need for talent in the field of science, an early start in the development of our young people along scientific lines of thinking is essential. One of the best ways of interesting pupils is through displays (projects, exhibits, *etc.*) where they can combine both mind and manual dexterity. Displays of various kinds for the classroom, such as a science day (or night), or Junior Academy of Science programs, have been used for many years. However, the impetus given through the establishment of Science Fairs under newspaper sponsorship has had such tremendous value that it is rapidly expanding all over the country.

Science Fairs tend (1) to focus attention not only of pupils but also of the entire community on science; (2) to encourage and inspire in youth the desire for scientific experimentation; (3) to recognize talented youth without exploiting them; and (4) to encourage further work in the field of science in college and industry. Another outstanding value of the Science Fair is the educational salesmanship to the community. Our school bands, orchestras, operettas, plays, *etc.*, give opportunity for the display of talent to the general public. The subject matter fields, in the past, have had little opportunity to let the parents, friends, *etc.*, see what progress has been made in these other educational procedures. Science Fairs fill this need as no other method could. One cannot comprehend the accomplishments of our youth until a Fair has been viewed.

To illustrate this point, try to visualize 1,633 entries completely filling a large athletic field house to capacity,¹ with table space two and one-half feet deep

¹ Fifth Greater St. Louis Science Fair at the Washington University Field House

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and more than one-half mile in linear measurement. Visitors from distant cities interested in Fair organization invariably remark after seeing this Fair that they could not visualize it even though having seen over-all pictures of it. The suggestions for starting and organizing a Science Fair² will not be incorporated in this article but may be obtained from the writer.

Many teachers have never had training in developing exhibits. This, however, should not deter them from using this most forward-looking teaching device. Many a bride could not cook before marriage but that was easily remedied by the application of good common sense, coupled with a good cookbook. The "cookbook" for Science Fair projects may be secured (usually without cost) from the chairman of existing Fairs merely by writing for a *Catalog of Exhibits*³.

Using the topics as found in one of these Catalogs for suggestions, choose one that is of interest and start developing the project. The ideas of the pupils, their parents, and friends (additional community value) make the work of the teacher much easier. Three dimensional and working models make for more attractive exhibits than flat poster-type exhibits. There is a wide variety of materials which may be used for these. Among the more common ones are: plywood (and other types of prepared boards), papier mache, common quick-drying repair plaster over molded screen wire (saves much material and weight), balsa wood, bars of soap, etc.

At the end of this article is a plan for a county-wide Science Fair. This may help the reader understand the mechanics of these institutions better, and also help him in his own planning of such activities. The preparation of exhibits should, of course, be related to science instruction. The approach may vary, but experience shows that the making of exhibits must become a part of the regular classroom procedure. At our school⁴ only two of the nine teachers in the science department have more than two or three entries in the Science Fair, but these two had over 100 exhibits. Pupils may be required to develop a project either individually or in a group (not over two or three to a group). Actual entry of the exhibit in the Fair is optional. But most of them develop something so nice that they want to enter it. The writer discusses possible projects (loaning pupils' *Catalog of Exhibits* for possible suggestions and ideas). Four or five laboratory periods at school are used to work on the various phases of the exhibit. Then if it is incomplete, the pupil takes it home to finish it. Review periods for receiving suggestions for improving exhibits, (lettering, spacing, size, etc.) by other classmates proves very beneficial in many ways and should become an integral part of procedures allowed. The other teacher⁵ has all the work done at home and uses one day a week for review suggestions. The retouching, changes, etc., result in much higher ratings by the judges than the exhibits would otherwise receive.

² "A Science Fair—Its Organization and Operation," *The Science Teacher*, February and April, 1949.

³ Write to: Greater St. Louis Science Fair, 911 Locust St., St. Louis 1, Mo.

⁴ Southwest High School, 3121 South Kingshighway, St. Louis 9, Missouri.

⁵ Miss Irma Hartnagel, Physiography Teacher.

A few schools develop their Science Fair exhibits as an after-school Science Club activity. Many teachers complain of the time wasted by the pupils. The writer had never used project teaching until asked to start the Greater St. Louis Science Fair. Deeming firsthand information advisable, he made the exhibits become a part of classroom procedure. Thus from actual experience, the conclusion has been reached that no more time is wasted in this teaching method than in any other. Time-wasters will operate as such in any laboratory work undertaken. The Science Fair approach to arousing and developing of interest in science is one of the best teaching devices that can be used. The opportunity to use it should be an advantage to all who will do so.

Another development of great value was undertaken jointly by Mr. Elmer Headlee of Kirkwood High School and the writer two years ago. With the slogan "*Study Science Where It Is Found*" a science summer school was organized.⁶ Because of interference with the regular routine of the entire school, it is difficult to organize field or industrial trips during the school year. Most communities are rich in parks and zoos (or comparable places for nature study) and industrial places abounding in scientific applications. St. Louis is generously blessed with unlimited resources.

With the formality of "accreditation" under control, the organization of a field and industrial visitation program into a summer school (there being no interference with other school programs) was easily accomplished. Regular summer schools here operate two or four hours a day for eight weeks, depending on the credit to be earned. Since the time necessary for plant visitation varies, with some plants desiring morning visits while others will only take groups through their establishment in the afternoons, it is very advisable that this program be set-up on a reverse arrangement; *i.e.*, eight hours a day for four weeks. Last summer, twenty-six industrial places were surveyed; two, two-day camping periods (embodying a camp activity program); various phases of plant and animal life at the St. Louis Zoo, Shaw's Garden, Tower Grove Park, Rockwood Reservation, *etc.*; rocks and minerals, river bridges; transportation, *etc.* were included in the work covered.

The benefits of such a program are very far reaching; only one or two will be mentioned here. As career day information it is unsurpassable. The pupils saw firsthand what the nature of the work actually was. Many made such good impressions and showed so much interest that various concerns asked some of the pupils to come back as soon as school closed to work for them for the balance of the summer. A few graduating from high school were permanently employed. These latter greeted us upon our return visit to the plant last year. It was gratifying to hear their complimentary remarks concerning the value they placed upon the activities of the science summer school.

Today, educators are including more and more "life adjustment" activities in the curriculum. The learning experiences provided by the Science Fairs and

⁶ *The Science Teacher*, February, 1951.

science-in-the-community courses suggested here can be a most effective tool in this more functional type of education for American boys and girls.

THE SCIENCE FAIR

DENTON COUNTY'S FIRST ANNUAL SCIENCE FAIR was held on APRIL 4, 1952, at the COUNTY FAIRGROUNDS in DENTON, TEXAS.

Purpose of the Science Fair

1. To focus attention on science experiences in school.
2. To stimulate a greater interest in science by all pupils.
3. To stimulate interest in scientific investigation over and above the routine class work.
4. To provide stimulation for scientific hobby pursuits.
5. To offer an opportunity for display of scientific talent through exhibits and demonstrations.
6. To recognize and commend youthful scientific talent.
7. To provide constructive suggestions for teachers and pupils of science.

Divisions of Exhibits

- I. *Senior Division*—Grades 10, 11, and 12—Physical Sciences.
- II. *Senior Division*—Grades 10, 11, and 12—Biological Sciences.
- III. *Junior Division*—Grades 7, 8, and 9.
- IV. *Upper Elementary Division*—Grades 4, 5, and 6.
- V. *Lower Elementary Division*—Grades 1, 2, and 3.

Planning an Exhibit

1. Study the items to be considered in judging in order to make the best possible showing in your exhibit.
2. Study the section on the "Protection of Exhibits" to be certain you understand what is expected of you.
3. Since many of the interested visitors will know little about science, remember:
 - a. To keep your exhibit clear.
 - b. To develop explanatory labels (test them on your friends and parents to determine if their meaning is clear).
4. Do not make your exhibit too elaborate. Simple, clear-cut, and dramatic presentation of an idea does more to show what you know than a large, exceedingly complex exhibit.
5. Complete your exhibit as soon as possible and show it at school to your classmates and teachers. Correct any faults they find with it.

Items to be Considered in Judging

1. *Scientific Thought*—Does the exhibit illustrate application of scientific principles and methods such as: controlled experimentation, utilization of theories, analysis, synthesis, and hypothesis? Does the exhibit illustrate a clear-cut scientific concept or principle? Is the exhibit explanation carried by the labels correct and adequate?

SCORE VALUE: 20 points.

2. *Originality of Concept*—Does the exhibit show original thinking on the part of the exhibitor, an original method or illustrating some scientific principle? Are the materials used in the exhibit made from raw materials, purchased materials, or borrowed materials?

SCORE VALUE: 20 points.

3. *Thoroughness*—Does the exhibit carry out its title or purpose? Does it meet reasonably rigorous tests for completeness, accuracy of observation? Are all the parts present? Is the description clear? Are all words spelled correctly?

SCORE VALUE: 20 points.

4. *Ingenuity, Technical Skill, and Workmanship*—Does the exhibit show imagination and skill in use of common everyday materials? Is the exhibit durably constructed and will it stand the wear and tear of demonstrations? Are all parts of the exhibit finished neatly and in a workmanlike manner?

SCORE VALUE: 20 points.

5. *Dramatic Value*—Are visitors attracted to this exhibit? Does it work? Can the lay public understand the exhibit with minimum effort?

SCORE VALUE: 20 points.

Judging Procedure

Each division will be judged separately. Each exhibit will be judged on its own merits. The judges will use the items to be considered in judging as listed and will give consideration to the degree in which standards are met. Each of the five items has a maximum value as listed. The judges will evaluate each exhibit on a point basis. The following awards will be made on the basis of the combined ratings of the judges.

First Place—Awarded in each division. The highest combined rating.

Second Place—Awarded in each division. The second highest combined rating.

Third Place—Awarded in each division. The third highest combined rating.

H. Evaluation of High School Science Instruction

JOHN G. READ

In this article, Professor Read points out some of the ways in which the administrator can judge the science program in his school through a carefully planned program of evaluation. He discusses three basic levels of evaluation in science and indicates how careful evaluation can help locate unusual science talent among pupils. Turning to sources of evaluation implements, the writer commends evaluation programs built up at the local level, and also considers some of the recent endeavors of the College Entrance Examination Board. He points out the importance of testing for problem solving ability and for attitudes related to science. He provides sample items aimed at these two areas of science instruction. The article is concluded with a list of commercial and institutional organizations which distribute secondary-school evaluating materials.

EVALUATION AND THE SCHOOL ADMINISTRATOR

EVALUATION practices in a science program can do two valuable things for an administrator. They can discover the real aims of his science teachers, and they can place pupils in rank order or can compare them with similar groups in other schools. Administrators and teachers frequently define and limit the science program in terms of goals whose elements can be measured either by testing instruments or by immediate overt acts, while they yet agree that many outcomes are measurable only in terms of the attitudes and ideals of a society whose

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members are now sitting, for a few hours each day, in their classrooms. (One factor which is possibly unique to science instruction is the role of the environment. The world of the high-school pupil is the world of science, and his teaching in science is done only briefly in the classroom.) At the end of twelve years of schooling, the good model science program will have given not more than a total of 900 hours of formal instruction in the classroom. In that time the teaching of science by agents outside the classroom has gone on during most of the waking hours of the average American youngster; so that one aspect of evaluation is the measurement of both school and environmental elements, whose integral we name maturation.

The instruments of evaluation should be those which will show growth and achievement in the ability to put facts and ideas together so that new experiences, no matter how strange to the pupil, can effectively be interpreted. Limited by native facility, there will also be growth and achievement in solving real problems of the environment. Some few pupils, say seven out of each thousand, will eventually be able to discover relationships among several situations and will predict or invent new solutions. These young people are our future scientists. The schools can discover them early and should encourage them, give them a program that will challenge and aid them financially, if necessary, so that they can continue in school until their capacities have been fully developed. To seek to make their fellow-students proud of and not jealous of their achievement is part of the problem of attitudes toward science and scientists (which is not necessarily the problem of "scientific attitude").

EVALUATION AT THREE LEVELS

Testing and evaluation in secondary-school science go on at three levels. The regular succession of marking periods requires teachers to use their own devices for obtaining a series of grades on which to base an estimate of a pupil's *rank in a class*. If adequate pre-testing has been done, they may also show pupil *growth* in the acquisition of facts and concepts or in skills. Short objective or essay tests, recitations, "papers" done on assigned reading, notebooks or workbooks, and laboratory exercises all contribute to the grade. Few commercial tests are used. Many teachers have a pool of good items from which they can draw, and at least one company proposes to supply such a reservoir of items in card-index form.

The second level of evaluation is typified by the project, enterprise, community research or activity, science fair production, set of visual aids (as pupil-made slides), or by the solution of a real research problem in science. All of these may take weeks or even a semester. Achievement of this nature is often "figured into" the grades on tests of the first level. Sometimes the teacher will require adequacy on all formal testing before giving any credit for the large project. Frequently the amount of time spent on a long-range enterprise will influence a final grade to some extent; that is, the grade will be partly for effort

and persistence as well as for excellence of production. Here as in level one, general attitude (which sometimes means keeping out of trouble!) may influence grades upward or downward.

Third, some attempt is made to evaluate the pupil's intellectual capacity for science apart from the local situation as seen above. It is here that commercial standardized tests are needed. Consistent high marks on teacher-made tests do not always mean that the pupil is a superior science student. This is true largely because teacher-made tests are designed to yield "passing" grades for the greater part of the class, and tests which would really challenge the superior pupil would be made up of items more than half of which would be too difficult for the rest of the group. But excellent tests are available not only for subject matter but also for some of the abilities, capacities, aptitudes—even attitudes, and these can compare individuals or groups with national norms and at the same time place pupils in rank order *and* discover those who probably belong to the seven tenths of one per cent of the population mentioned above—the future scientists. (This is not to say that teachers cannot discover these able youngsters without the aid of commercial tests. After-school clubs and conferences bring out the interest and excitement over science which is typical of the science-minded pupils. They demand to be heard. They have home laboratories and zoos or aquaria. But a suspected science-talented pupil should, for his own sake, be screened by carefully prepared testing materials both in science and mathematics before he is encouraged to go on to collegiate science work.)

THE NEED FOR DISCOVERING SCIENCE TALENT

It is necessary to stress the need for discovery of the able science pupil. Many superior pupils drop out of school. Economic and social pressures are applied to gifted as well as to slow pupils. Henry Chauncey, President, of Educational Testing Service says, in an annual report (1950-51) to the Board of Trustees:

The extent to which our talent reservoirs are depleted by drop-outs may be understood more fully by considering that even among the group graduating from high school there are at least as many superior pupils who do not go on to college as who do go.

Economic factors play a considerable part in many of the drop-outs, but it is significant to note that the cultural and psychological factors which follow in the train of the economic factors play an even larger part. Lacking encouragement and incentive to continue, many . . . drop out who could actually go ahead with even a slight amount of assistance.

In a report recently issued by the Commission on Financing Higher Education, Havighurst and Rodgers estimate that of all superior youth, defined in terms of ability to profit from post-high school education, forty per cent do attend institutions for advanced training, an additional twenty per cent would attend if financial assistance were provided, but the remaining forty per cent would attend only if their individual motivation were increased, whether or not financial assistance were provided. This forty per cent would appear to warrant particular attention at this time.

Tests which have been available for many years can readily be administered to provide a reliable indication of a pupil's potential for advanced training. With the use of such tests, pupils . . . can be singled out for special attention and help. However, such identification and encouragement of talented young people cannot be delayed until the end of the high-

school period. By that time, many have already left school; others of high potential have by then been enrolled for two or three years in various terminal curricula, rather than in college preparatory courses.

We cannot as yet measure all the factors which make for success in professional and scientific endeavor, but we do know that in most of these fields, verbal ability and quantitative ability are of primary importance. Fortunately, both these abilities can be measured reliably as early as the eighth or ninth grade; there is nothing to prevent our identifying talented individuals before the drop-outs occur in high school, and before it is too late to ensure adequate pre-college training.

Nor should the teacher's personal gain from the evaluation of his pupils be forgotten. Watson, in a chapter on evaluation, says:¹

To what extent has the instruction been successful? . . . An answer . . . provides some evaluation of the effectiveness of the techniques used in the course—a question which rests heavily on the conscience of all serious teachers. Evaluation is the effort to estimate as best we can how well we have achieved what we set out to accomplish . . . we are appraising not only the students, but also ourselves—our plan of operation and its execution. Such evaluation, made as specific as possible, shows us our shortcomings and allows us to make alterations (we hope, improvements) for the next presentation.

It cannot be denied that such evaluation of successful pupils' progress is frequently the only encouragement that science teachers receive, nor can it be ignored as a factor in the improvement of the science program.

LOCALLY PREPARED EVALUATION PROGRAMS

Time for the kind of science teaching which will allow and require practice in problem solving is now needed. The problem of doing better with smaller areas of subject-matter is local, and must be decided on the basis of the needs of the pupils. Yet it is obvious that textbooks with over 800 pages pose a problem in teaching and evaluation.

Some teachers feel that problem solving is beyond the reach of many pupils. Nevertheless, boys and girls come to school, they eat, they work, they eventually have homes of their own—and if they bet on horses they try to solve problems the unreliability of whose data they do not understand, but they, nevertheless, attempt them.

Very few school situations, not excepting those in science, tax even the slowest pupil's ability to see through vicarious or contrived situations which are somewhat like those which he reasonably can be expected to encounter in the near future, outside of school. Why do not teachers test for success in applying knowledge of facts and concepts to new situations? Why is it that so much testing stops with the vocabulary, the manipulation of figures within a type-problem framework, and, at best, with the recognition of a verbalized principle among four others in a multiple-choice situation? The answer is largely lack of time. Science teachers have all the academic duties of other teachers. They keep house with hundreds of items of science equipment. They *should* spend an

¹ Cohen, I. B., and Watson, F. G., *General Education in Science*. Cambridge: Harvard University Press, 1952, p. 205.

hour in preparation for every demonstration—and, if they think it wiser to do this than to spend preparation time in the devising of high-level test items, they may be right. Good items of this type are difficult to make. They must be descriptive of a situation, at some length. They often require pictures or diagrams. And, in addition, they must be duplicated or put on the chalk-board.

Difficult though the accomplishment may be, there is much value in evaluation programs prepared on a local level. If a local science committee is set to work with instructions to define and devise an evaluation technique *from the top down*, it will have to consider goals, procedures, costs, texts, individual differences, and statistical analysis before it produces a single item. But produce it will, and slowly it will build up a pool of items upon which teachers can draw for examinations.

THE WORK OF THE COLLEGE ENTRANCE EXAMINATION BOARD

Administrators may have the feeling that, until colleges become interested in this sort of testing, there is little point in discussing it for the college preparatory groups. The College Entrance Examination Board tells: of experimental work leading to a possible general test in science, not to replace but to supplement present procedures:²

Two tentative experimental tests were developed. One of these, Test I, a General Test, consisted of fifty general items without regard to subject matter fields. In Test I, approximately twenty questions were in the area of methods of science, ten in the area of interpretation of science reading materials, ten in application of principles of science, and ten in analysis of observation and experimental data. As can be expected, the categories overlapped.

A second test consisted of two parts: Part I was made up of general items; Part II was made up of separate physics, chemistry, and biology sections. In these separate sections the items had strong subject matter loading. The difficulty of the items was to depend upon a combination of the recall required, the mental process involved, and, to a lesser extent, the concept involved.

The members of the Committee on Science Testing submitted some 150 test items. Of these, ninety-seven were considered promising. After being edited and graded in what appeared to be an ascending order of difficulty these ninety-seven items were administered to several groups of pupils and teachers,

On the basis of these crude experimental excursions, the following notions could be tentatively stated. There was general agreement by the pupils tested, and by the teachers, that this was not alone or even principally a test of science content, but that in order of emphasis the items stressed scientific thinking, understanding of scientific method, understanding of principles of science, and recall of content.

TESTING FOR PROBLEM SOLVING ABILITY

It may be helpful to give some samples of the kinds of items which involve simple and complex problem solving. (It will be remembered that early in this article the thesis was advanced that the use of this type of item in high-school science testing is indicative of imaginative and effective science instruction.)

² Brandwein, Paul. "Science Teaching and the Board's Science Tests," *The College Board Review*, No. 3, March 1951. (See also "The College Board's Science Tests," *The Science Teacher*, Vol. XIX, No. 3, April 1952.)

Test Item for Simple Problem Solving Ability

The old folks say that before a storm animals and children are restless and noisy. It is true that air pressure, wind direction, temperature, and the color of the sky change before a storm. It is also true that children do not notice the weather much when they are indoors.

Which one of these statements could you test for yourself if you were interested in the old folks' saying?

1. Ducks can feel the cold before the storm arrives.
2. Cows always face the wind when they are outdoors.
3. People's ears feel queer just before a storm.
4. Dark clouds frighten children.
5. Reading the thermometer will tell a storm is coming.

The answer (2) can be tested. It does not prove that animals or children are restless, but the question was not to that point. The problem here is not really one of science content. It is the problem of sorting directions and evidence. Here is another one, more typical of what we have come to expect as "nearby experiences."

Test Item for Simple Problem Solving Ability

On a hot day in August, the Memorial Bridge, over the river, leading to the new homes on the hill, away from the city, opened to let a tugboat and three barges go through. When the two halves of the bridge came down to the level again, the bridge would not close. Which one of these things would it be best to do?

1. Hammer the steel girders to make them shorter.
2. Have the fire-engine pump water from the river onto the girders.
3. Let the heavy fire-trucks run out on the bridge and push it down.
4. Wait until the sun goes down.
5. Let the tugboat pull the two halves of the bridge down.

The principle here is that of molecular motion as shown in the statement "Heat expands metals, loss of heat contracts them." There is also an element of plain common-sense thinking. The bridge would close soon after sundown, but during that time the fire-trucks might need to reach the new houses on the other side. One not-advertised bit of knowledge is that the river water would always be cool enough to shrink the bridge back to size.

Test Item for Complex Problem Solving Ability

A new road was cut through a basalt (trap-rock) hill for a half-mile. Signs were put up saying "Danger, Falling Rocks!" but there were two serious accidents when rocks rolled down the steep slope onto the highway on cold nights. The contractor agreed to do something to make things safer. Which of these was the best thing to do?

1. Install a simple heating system to keep the cold from cracking the rocks.
2. Put up flashing warning lights to slow down motorists as they go by the ledge.
3. Clean off the loose rock with a compressed-air drill.
4. Put a fine steel net over the whole face of the ledge so as to keep the rocks from rolling down.
5. Dig a deep ditch between the sloping walls of the ledge and the highway, and put up a wall between the ditch and the roadway.

Here there are two principles at work; expansion and contraction, due to heat, break off the rocks, and will continue to do so. The other principle is that gravity causes objects to get as near to the center of the earth as possible. This was the roadway; now it is the ditch. The wall, of course, is to keep the cars out of the ditch. The idea of the net was not too bad, and so is a good distractor. Here the economic factor is important.

The common-sense aspect of this kind of testing mentioned above was the sort of thing that pioneer youngsters dealt with daily. Solutions were arrived at by a scientific method—the method of human thought when it deals with the real world. Changing channels on the TV set is no substitute for the chores that had to be done by every boy and girl. Parenthetically, pupils like these items. The answers offer several reasonable solutions, and the youngster is not told whether he got the item "right" or not. He has the feeling that his answer was a good one, and so achieves a measure of satisfaction. The items, when properly designed, are fruitful of analysis into "degrees of rightness." Placed on slides in picture form, they invite open-ended discussions of science problems of the environment.

TESTING FOR ATTITUDES

The real over-all purpose of teaching science is to make good citizens. This is going to involve value judgments by pupils as to what in science and in scientists is good. It is going to involve them in human relationships where scientific knowledge can change their attitudes. It is going to produce congressmen and judges who must appreciate the work of engineers and doctors. Along with 150 million citizens they all will play their parts in the kind of world we will have twenty years from now.

It is not safe to say that "correct" responses on attitude tests will ensure the corresponding behavior now or later. In the sample item below, it is quite possible that the high-school senior will answer the item by marking number 3, and yet be hesitant actually to take part in the group discussion. Further, he may change his attitude toward the illness called alcoholism and yet with a closely parallel situation (mental illness, for instance) he may be unconverted.

Test Item Concerning Attitudes

Alcoholism is now known to be a medical problem rather than a moral problem. If one of your classmates has an uncle who lives with him, and is an alcoholic, you should;

1. Never mention the uncle to your classmates.
2. Never talk about alcoholism in front of your classmate.
3. Be willing to discuss alcoholism in a small class group of which your classmate is a member.
4. Let someone say that alcoholism is inherited and not correct the speaker.
5. Never be seen on the street with this classmate.

CONCLUSION

And so to return to the relationship among the administrator, teacher, and the science-program. Some aspects of a good program can be discovered by examining the tests used. Some evidence of good teaching can be seen in other kinds of evaluation—those overt acts, in which pupils plan and engage in and which show their interest and enthusiasm for science, like science fairs, projects, field trips, publications, and assemblies. That teaching program which is continuously scanned for high-order testing and pupil activity can itself be evaluated

by an administrator as are the pupils in the program. And as challenging testing for science classes and an opportunity for activities on the part of the pupils will reveal the able science pupil, so will interest in and aid to the science program on the part of the administrator discover or create superior science teachers.

SOURCES OF COMMERCIAL AND INSTITUTIONAL TESTS IN SCIENCE

There are many places where science teachers may turn for help in preparing their programs of evaluation. The tests listed below are current publications of companies and schools producing or distributing secondary-school evaluating materials. In some cases these organizations also produce tests with earlier copyright dates. Administrators can obtain complete information and sample tests by writing to these addresses. For the sake of brevity, single-test authors' names are not given unless they occur in the title of the test; many tests have several authors and editors. Editors of large testing programs are included. A few tests listed may be out of print. Sample tests of the New York Board of Regents are to be obtained from the Board of Regents of New York. They are published in Review Book form by such companies as the Oxford, the Republic, and the Cambridge publishing companies in New York. Other examinations may be obtained from universities other than those here listed which have college entrance examinations. The writer will be happy to be informed of any tests now current which are not included.

Acorn Publishing Co., Rockville Center, New York

National Achievement Tests—General Science Test, Grades 7 to 9; 1939.

California Test Bureau, 5916 Hollywood Blvd., Los Angeles, California

Calvert Science Information Tests, Grades 7 to 9.

Occupational Aptitudes and Interest, Part 6, Scientific Aptitude, Grades 9 to 13.

Columbia University, Columbia Research Bureau, New York

Physics Test, high school.

Educational Test Bureau, 720 Washington Avenue, S. E., Minneapolis, Minnesota

Analytical Scale of Attainment, Elementary Science, Grades 7 to 8 and 9.

General Achievement Test In Chemistry, high school.

Reading Scales in Science, Grades 7 to 12, 1938.

Educational Testing Service, 20 Nassau Street, Princeton, New Jersey: 4641 Hollywood Blvd., Los Angeles, California (Barnard S. Cayne; Head, Science Section of Test Development)

Science Test for Grades 7 to 9.

General Science Test, high school.

Biology Test, high school.

Chemistry Test, high school.

Physics Test, high school.

Co-operative General Achievement Tests

II. *A Test of General Proficiency in the Field of National Sciences*, Grade 12 and sup., Grades 10 and 11.

United States Armed Forces Institute (USAFI)

3. *Interpretation of Reading Materials in the Natural Sciences*, Grade 12.

- Evaluation Instruments of the Eight-year Study
Logical Reasoning Test, Grades 10 to 12.
Interpretation of Data Test—Lower Level, Grades 7 to 12.
Interpretation of Data Test—Upper Level, sup.
Test of Applications of Principles in General Science, Grades 9 to 12.
Test of Application of Principles in Biology, high school.
Test of Application of Principles in Physical Science, (materials taken from the field of physics), high school.
- Iowa, State University of, The Bureau of Education Research and Service, Iowa City, Iowa
Physical Sciences Aptitude Examination, Grades 12 to 13, 1943.
- Kansas State Teachers College, Bureau of Educational Measurement, Emporia, Kansas
Kirkpatrick Chemistry Test, high school, 1941.
McDougal General Science Test, 1941.
- Ohio State Department of Education, Columbus, Ohio
Ohio Scholarship Tests, high school, 1946-47.
Biology, Chemistry, General Science, Physics tests.
- Psychological Corporation, 522 Fifth Avenue, New York 36, New York
Differentiated Aptitude Tests, high school.
Verbal Reasoning.
Numerical Ability.
Abstract Reasoning.
Spacial Relationships.
Engineering and Physical Science Aptitude Test.
- Public School Publishing Co., 509-13 North East Street, Bloomington, Illinois
Dvorak General Science Scales, Grades 7 to 9.
- Science Research Associates, 57 West Grand Avenue, Chicago 10, Illinois (also distributors of tests by other companies)
Kuder Preference Record(s).
- Stanford University Press, Stanford, California
Vocational Interest Blank for Men, 1938.
Vocational Interest Blank for Women, 1947.
(both have sections on Mathematics-Physical Science Teacher; that for Men has section on Mathematician, Engineer, Chemist; for Women, has sections on Dietician, Laboratory Technician, Nurse, Housewife)
- Washington University, The George, The Center for Psychological Service, Washington 6, D. C.
General Science Test for Prospective Nurses.
- Wisconsin, University of, Bureau of Guidance, School of Education, Madison, Wisconsin
Wisconsin Biology Test, "Wisconsin Achievement Test, Biology, (Form A)," high school, 1937-39.
Chemistry, high school, 1937-39.
General Science, high school, 1937-39.
Physics, high school, 1937-39.
- World Book Co., Yonkers-on-Hudson, New York (Roger T. Lennon, Director, Division of Test Research and Service; Walter N. Durost, Editor; and Victor H. Noll, Co-ordinator for Science Tests)
Anderson Chemistry Test, high school, 1952.
Dunning Physics Test, high school, 1952.
Nelson Biology Test, high school, 1952.
Read General Science Test, Grades 7 to 9, 1952.
Essential High School Content Battery (science test not separate).

CHAPTER V

Special Problems in High School Science Education

A. Teaching Scientific Attitudes and Methods in Science

J. DARRELL BARNARD

In this article, Professor Barnard examines the rationale underlying the frequent inclusion of scientific attitudes and methods among the objectives of science education. After discussing the nature of the scientific method(s), he outlines research evidence on the extent to which education along these lines is actually occurring in today's schools. He concludes that one reason teachers do not do better in these areas is that they are unclear concerning the objectives—in terms of behavior—of learning related to scientific attitudes and methods.

The writer next proposes ten statements which describe behavior pupils will exhibit as they improve in their possession of scientific attitudes and ability to use scientific methods. Finally, he describes the kind of teaching we *should* have, as compared to that we *should not* have, if our science pupils are to make progress toward the realization of these objectives.

THERE is general agreement among both the citizen and the professorial educator that public education today should be orientated toward the preservation and improvement of our democratic way of life. There are divergent points of view, however, as to how education is to achieve this function. These differences may arise from a lack of agreement regarding the fundamental assumptions underlying democracy and the import of those assumptions as guides to the types of behavior which should constitute the outcomes of education.

The assumption that, in a democracy, policies should be made by people who, in turn, will be affected by those policies, is fundamental to our democratic way of life. This assumption has profound implications for education. Democracy will become decadant when we as Americans relinquish the right and responsibility dictated by this assumption. The possibility of Americans forfeiting this right will be enhanced by the ineptness and unwillingness of people to exercise their responsibility for sharing in decision-making. Stating it positively, we can preserve and improve our democratic way of life by improving our individual and collective abilities to exercise intelligence in making de-

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cisions. The development of this ability or behavior should, therefore, be a fundamental goal for public education in a democracy.

If science education is to maintain a position of respectability in the general education of young people in the secondary school, it must contribute to the development of their abilities to make intelligent decisions. Science educators should be asking themselves how learning experiences in science can be planned to modify the behavior of young people in a manner that makes these young people more effective in this fundamental responsibility of citizens in a democracy.

For many years, national committees¹ responsible for reports on secondary-school science have recognized that an adequate program of science education must not only help young people understand selected science generalizations and their applications to everyday living, but must also contribute to the development of scientific attitudes and abilities in the scientific methods. Most modern curricula in science education have included both the attitudes and methods of science among their objectives. These are the objectives of science education that promise to contribute most to the education of young people to become competent citizens in a democracy.

There has been some controversy as to whether there is a scientific method, except as it might exist in the abstract thinking of some people. When the processes used by different scientists in making their various discoveries are examined, it would appear that there are as many methods or processes, possibly, as there are scientists who conduct fruitful investigations. There do appear, however, to be some common elements in the methods used by scientists which distinguish their investigations from the non-scientific and reduces the probability of their conclusions not being acceptable to other scientists.

A number of investigations have been conducted in an attempt to clarify the attitudes or predispositions of the scientific mind and the common elements of scientific methods.² These are significant investigations in that they provide the science teacher with some rather definite clues to behaviors for which he should be teaching if he is to exploit science instruction for its maximum educational value.

For some time now, leaders in science education have advocated scientific attitudes and elements of scientific methods as objectives of science teaching. Research studies have revealed something of the nature of these two objectives.

¹ Commission of the Reorganization of Secondary Education, *Report of Subcommittee on the Teaching of Science*. U. S. Bureau of Education, Bul. No. 26. Washington, D. C.: Government Printing Office, 1920.

Program for Teaching Science. Thirty-first Yearbook of the National Society for the Study of Education, Part I, Chicago: University of Chicago Press, 1932.

Progressive Education Association. *Science in General Education*. New York: D. Appleton Century Co., 1938. American Council of Science Teachers, National Committee on Science Teaching, *Science Teaching for Better Living*, National Education Association, Washington, 1942.

Science Education in American Schools, Forty-sixth Yearbook of the National Society for the Study of Education, Part I, Chicago: Univ. of Chicago Press, 1947.

² Curtis, F. D., *Some Values Derived from Extensive Reading in General Science*. Teachers College Contributions to Education, No. 163, 1924., pp. 41-49.

Keeslar, Oreon, "A Survey of Research Studies Dealing with the Elements of Scientific Method as Objectives of Instruction in Science," *Science Education*, 29 (October, 1945) pp. 212-216.

Other investigations have demonstrated that, under certain conditions, both the attitudes and elements of scientific methods can be taught. What, though, is the evidence regarding the extent to which science instruction in American secondary schools is providing for these learnings? A survey of secondary-school science was conducted in 1932.³ It included an analysis of 160 courses of study in science from different sections of the country as well as observations of selected science programs in schools using these courses of study. Objectives related to scientific attitudes and scientific methods were commonly listed in the courses of study. Teachers in the schools observed were asked how they taught for these objectives. Their responses indicated some teachers believed that a study of science automatically resulted in the achievement of these objectives; that it is not possible to teach young people to think; that an occasional lesson on critical thinking is adequate; or that young people learn the attitudes and methods of science by observing the teacher. A more recent study⁴ dealing with one element of scientific method indicated that progress, both in textbook writing and classroom practices, toward adequate consideration of scientific methods is extremely slow.

The question might reasonably be raised as to why teachers of science in the secondary school do not give greater consideration to the development of scientific attitudes and abilities in various elements of the scientific methods. There are many reasons but, from experience in both the pre-service and in-service education of teachers, it would seem that a lack of clear understanding regarding the behavioral objectives to be sought is one fundamental reason.

Science teachers need to consider seriously the research dealing with the attitudes and methods of science and use it as a source of clues to the behaviors which they should attempt to develop through science teaching. The behavior objectives listed in the following paragraph were developed from clues suggested by the findings of studies dealing with the attitudes and methods of science and are considered defensible objectives of science education.

Experiences in science at the secondary-school level should improve the young person's pre-disposition and ability to:

1. Ask questions about and look for reliable explanations of phenomena he does not understand.
2. Exercise an open mind and to respect another's point of view.
3. Recognize and state clearly problems that need to be solved.
4. Determine the elements of a problem which need to be considered in solving the problem.
5. Use effectively the skills involved in locating, collecting, organizing, understanding, and testing the reliability of information needed to solve a problem.
6. Devise and evaluate methods (experiments, surveys, etc.) for obtaining evidence to solve problems.

³ Beauchamp, Wilbur L., *Instruction in Science*, U. S. Office of Education, Bulletin, 1932, No. 17, Monograph No. 22, Washington, D. C.: Government Printing Office, 1933.

⁴ Osbourn, Ellsworth S., "Assumptions in Ninth-Grade General Science." Unpublished doctoral dissertation, New York University, 1950.

7. Evaluate evidence in terms of its adequacy and reliability and to suspend judgment until reliable evidence can be obtained.

8. Generalize from related facts to form summary statements, hypotheses, or conclusions.

9. Recognize hypotheses and to put them to appropriate tests before accepting them as conclusions.

10. Apply pertinent generalizations or principles of science to the solution of problems.

If science teachers are concerned about teaching the attitudes and methods of science so that they relate in a more functional manner to the education of young people in a democracy, they need to direct both the content and methods of their courses toward the achievement of positive overt behaviors such as those listed above. An attempt will be made in the remainder of this paper to illustrate by contrasting situations the directions which science teaching should be taking if the attitudes and methods of science are to become functional learnings.

The curiosities of young people must be revived. **Young people must be encouraged to ask questions and to consider their science class as a place where they can discover answers to many of their questions. In such a situation the role of the teacher will be changed.** *In the classroom there will have to be less of* "Tell me where the pituitary gland is located"; "Define a hormone"; "Name three important endocrine glands and tell the function of each." *There will be more of:* "Have you ever wondered why you have those peculiar sensations whenever you are frightened or angry?"; "Have you boys ever wondered why your voices change at a certain age?"; "Have you ever wondered why you act like you do at different times?"

Opportunity must be provided for young people to explore problem areas, identify specific problems and determine their relative importance. *There will have to be less of:* "The next problem in your text deals with the manner in which green plants manufacture food. Read pages 361 to 364 and be prepared to discuss this material in class tomorrow." *There must be more of:* "Have you people noticed how frequently the problem of producing sufficient food for our ever-increasing world population is discussed in magazines and newspapers lately? Here are several articles from magazines and clippings from newspapers which I would like to discuss with you. See if you can find other articles that deal with this general problem and bring them to class tomorrow. After we have had an opportunity to discuss the general problem, we'll see if there are some more specific problems which we might study."

Young people must be taught how to analyze problems for study. *There must be fewer instances where the teacher says:* "I have listed four questions on the board for your homework. You will find the answers to these questions in your text. Write out the answers and hand them in tomorrow." *There must be many more instances where the teacher says:* "Here is the problem which you people stated as the one which you considered most important to study next. Let's see if we can break it down into the more specific problems or questions which will have to be answered in solving the problem."

Young people must be taught how to locate information as well as to devise means of obtaining it. *In science classrooms there must be less of:* "You'll find the answers to the questions on pages 370 to 372". *There will have to be more of:* "Since we'll find it necessary to use a number of materials in our library, today we are going to the library where the librarian will show us how to locate these materials;" or "Some of you have suggested that a survey be conducted to obtain information about the third problem. Today we are going to discuss ways of conducting surveys and make plans for this proposed survey;" or "Some of you people are having difficulty in locating specific information in books. Today I am going to meet with those of you who want help. Bring your textbooks and we'll practice locating information and picking out important ideas from the paragraph."

In science classes young people should have experiences in planning experiments to answer questions and test ideas. If this is to be achieved, *there must be less of* "Today you will perform experiment 22 in your lab manuals. You'll find the necessary materials at each table. Complete the exercise according to the directions in your manuals. Fill in the blank spaces on page 174." *There must be more of:* "As you will recall, yesterday a number of you were quite positive that you could tell the difference between oleomargarine and butter by tasting it. Some of you argued that people could not tell the difference. As you know, experiments in science can be used to answer questions or test ideas. How can we plan a controlled experiment to answer this question?"

Young people must be taught how to organize factual material so that it might be used effectively in solving or understanding better the problem being studied. Teachers should re-examine the validity of the ends which they are seeking. *There should be less of:* "Take notes on what you read so that you can use them in reviewing for the examination." *There should be more of:* "Outlining is a valuable technique for organizing information which you may collect about your problem. There are several paragraphs of material on the mimeographed sheets which have been given to you. Today we shall work together on this material so that I can help you improve your skill in outlining;" or "Some of you want to use tables in organizing material, for the report on your problems. Let's take some time today to learn how to construct a good table."

In their science classes, young people will have to be taught how to generalize from facts in order to derive conclusions for their problems. *There must be fewer science teachers who say:* "Remember the five statements listed in the summary of this chapter." *There should be more who say:* "Each of you has collected many facts about this problem. Our next job is to learn how we can organize these many facts into several good summary statements;" or "I have listed several facts on the board. As you read through the list, you will note that they are rather closely related. See if you can tell how these facts are related, then write one sentence which states the relationship".

Science pupils must be taught how to evaluate authority. *There must be fewer classrooms where the teacher states: "That is not the way it is printed in the book;" but more of: "What criteria can we use for determining authority? Is this authority one that meets all of our criteria?"*

In science classes young people must be taught how to evaluate conclusions. *There must be fewer occasions where the instructor says, "These are the conclusions and it's up to you to learn them." There must be more occasions where the instructor asks, "Upon what evidence was the conclusion based? Does the evidence support the conclusion? Does the conclusion go beyond the evidence? What assumptions must one accept before he can accept this conclusion?"*

This brief review of some selected classroom situations indicates that both the attitudes and the methods of science apply wherever problems are being studied as the basic experience in science curricula. But in order to teach the attitudes and methods of science, teachers must:

1. Understand how the attitudes and methods of science relate to positive overt behaviors
2. Be familiar with the skills involved and teaching techniques for developing them
3. Plan experiences that will give young people guided practice in the behaviors
4. Be willing to provide adequate time in their courses for these experiences.

B. The Atomic Age and Its Relation to High School Science Teaching

R. WILL BURNETT

Prof. Burnett opens his article with a retrospective glance at recent air-age education, and makes a plea that education for the atomic age will not duplicate some of the shortcomings committed in the previous effort. He then discusses the characteristics of the atomic age, including both its social implications, as well as the threats and promises it offers along more purely scientific lines.

Turning then to the responsibilities of modern science teachers, the writer discusses them in terms of the knowledge which he must assimilate and organize and the general education which he must pass on to all his pupils. The article is concluded with a list of major teaching objectives for literacy in the atomic age, including the principles which pupils should know, the skills which they should possess, and the behaviors which they should exhibit if the objectives of education for the atomic age are to be realized.

THE responsibilities of the public schools in this age of crisis, commonly termed the atomic age, are as complex and difficult to discharge as they are important if democracy is to survive and advance. Basically, they represent the development of certain allegiances, understandings, and skills that have always been necessary in a people determined in self-government. But the task has been

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made complex by the scientific and technological developments of the past few decades and the social, economic, and political problems which these scientific achievements have produced. The over-all responsibility of the schools is to develop the informed intelligence necessary for a people to cope successfully with these problems.

The proper work of the science teacher is to be found in this over-all task. His contributions to the education of the young are specialized and must be integrated with those of other specialists if the job is to be well done. In addition, of course, the science teacher must provide a sound foundation of knowledge in the fields of science as such for those young people whose aptitudes and interests bear the promise of leadership roles in the scientific and technological age so well epitomized by the term atomic age.

THE NATURE OF THE ATOMIC AGE

There is no real danger that terms such as the atomic age will become clichés devoid of meaning. During the past war, school after school developed courses on the air age that were as thin in meaning and vitality as the term was shopworn. Textbooks were written and used that contained only more or less technical analyses of the kinds of information desirable for the pilot but essentially worthless to the average individual and citizen. The air age symbolizes a world of national states shrunk to unity by the fact of the airplane. It represents a period of history in which new social insights and skills are necessary for civilized survival. It suggests a time in which man has created the mechanistic base for vast human betterment and advancement never dreamed of in an earlier day. At the same time, it epitomizes a shrunken world where mass suicide becomes possible. Yet many school programs treated the air age as if it required nothing more than a superficial account of preflight aeronautics. The air age requires a re-assessment and modification of instruction in the high schools that will enable young people to develop the intellectual, emotional, and ethical maturity required by a period of human existence heavily influenced in its every dimension by the fact of the modern airplane. Seen in the proper perspective, the atomic age is but another term for this same modern world of swift social change with the addition, of course, of the vast power of the atom and its chain reaction of social, economic, and political issues.

There is danger that education for the atomic age will be developed on grounds as superficial as those on which air age education was sometimes developed. There is danger, on the one hand, that administrators may consider the job done when a separate course or new unit is established providing a superficial knowledge of the release of atomic energy. There is danger, on the other hand, that the present and potential impact of the controlled release of nuclear energy on our lives may be underrated and that school programs will remain unaffected by a force so vital that our lives, if not our understanding, are even now being affected deeply and pervasively.

There are certain facts about the atomic age that must be understood before the term can be more than a cliché worthless in appraising the proper job of education or that of the science teacher. These facts seem fairly obvious, yet they appear to have escaped the attention of many educators, if the curriculums of our schools are the criterion of that attention.

First, the modern world is highly interdependent and, in many connections, inextricably so. Modern, industrial nations are economically interdependent. Yet the assumption is sometimes made that the genius of modern science can enable us or other peoples to synthesize and substitute materials so that nations can live in splendid isolation. It cannot be done. Let us take the modern airplane as an example. An airplane *can* be built with a restricted range of materials. But its construction would be more expensive and its efficiency and durability considerably less than when it is made with the most appropriate materials made available by trade with the peoples of the world. A modern American-made transport plane may have asbestos secured from South Africa or the USSR; nickel from Canada; tungsten from China, British Malaya, Australia, Belgium, or Mexico; chromium from Rhodesia, Cuba, or the Philippines; vanadium from Peru; tin from British Malaya, China, or Bolivia; cobalt from Canada, Belgium, or Finland; manganese from the USSR, Africa, India, or Brazil; and platinum from Colombia, Canada, or Africa, to enumerate a few of the necessary materials in a modern transport plane and their sources. The airplane is thus a symbol of the interdependence of the material world which the youth of this nation must come to understand and cope with successfully.

The interdependence of the world is also seen in the avalanches of propaganda that go over the air waves and through newsprint from nation to nation. The forums of the United Nations, of course, have added to the already tremendous amount of information and misinformation that has spread to every civilized spot of the earth from a hundred national and state origins. Young people must become critical readers of and listeners to this avalanche of information and misinformation.

In addition, the community of scientists and scholars is, by definition, a world community. It has been in the past, and may become again, a great force toward reciprocal sympathetic understanding of the peoples of the world and for peace. The various iron curtains of the world and the ideological attempts of the Soviets to dictate truth into being have stamped out a portion of this community of the seekers after unbiased truth, but these restrictions have not destroyed the unity of scholarship. Young people must understand the necessity of world-wide freedom for the pursuit of truth and be prepared to fight for its preservation and extension.

Finally, and there should be no mistake about it, the world is virtually engaged in modern war. Our youth should understand the catastrophic nature of modern, atomic warfare and be prepared to fight for peace while standing ready to support their country in war if that contingency becomes necessary.

A *second* major fact about the atomic age is that it is a producing (or at least a potentially producing) giant. The world problem is less that of producing than that of consumption. This is not a Pollyannaish statement. Nor does it ignore the serious problems growing out of dwindling stocks of mineral wealth and of eroding soils. If the best techniques of resource utilization known are applied on a world-wide scale and are coupled with the social engineering necessary to provide for an equitable distribution of the produce, there is enough to provide for all at the present and in the foreseeable future. The final hope for real peace and justice throughout the world rests on the assumption that the power, mineral, and biological resources of the world are sufficient to provide a decent standard of living for the peoples of the world.

The backward ("have not") peoples of the world are aware that this assumption is based on quite realistic investigations of the world's potential productivity. They have rejected their colonial status. They are determined to live in decency. The degree to which the powerful nations assist them in this endeavor or stand in the way of their development is one degree to which we can expect an ultimate lessening of the present crisis or its final explosion into a world war of consuming violence. Young people should understand the technical possibilities for world-wide freedom from want and should be prepared to engage in the necessary social engineering to achieve this goal.

A *third* major fact about the atomic age is that, although the world is inescapably one resource-wise and in terms of communications and transport, it is politically divided into nation-states bearing a heritage of mutual distrust, fear, suspicion, and downright hatred. It is a world nursing its remembrances of past butcheries, injustices, and oppressions. It is a world of peoples of diverse ideologies, mores, social institutions, and codes of behavior. It is a world still committed to unlimited national sovereignty and—by default—to international lawlessness. Yet it is a world of growing experience and trust in the machinery of internationalism. It is a world that shows evidences that it might learn its lessons from the past and develop real world law instead of blowing itself to bits. These things must be learned and learned well by our young people. They must understand the historical backgrounds of our present world and develop insight into the various responsibly stated plans to lessen our present conflicts.

There is a second set of major truths about the atomic age that have derived directly from the fact of atomic energy. The *first* of these is this: For the first time in history it is possible for civilized man to commit mass suicide. This is not likely but, for the first time, it is possible. This total destruction would not occur over night through push button warfare. But, given months or years, modern atomic war could result in the brutalization, the degradation, and the loss of such numbers of human beings that civilization as we know it might cease to exist. This, too, must be learned by our youth. A fear psychology should not be developed. There has been too much of this already. But young people should have an opportunity to study the facts of atomic destructiveness dis-

passionately. The study should result in a sounder basis from which they can appraise our foreign policy, assist in its development, and, if war should come, defend their country free from vague fears and hysteria.

A *second* fact grows out of the first: All over the world, mankind has been sobered by the terrible power of the atomic bomb and is searching, as never before, for means by which he might turn from the patterns of violence of the past to a road leading to a durable peace. Several roads to peace have been proposed in some detail by various responsible and patriotic groups. Each of these should be studied by our youth and considered for adequacy in terms of the problems of controlling atomic and other weapons of destruction. They should be considered too in terms of the forces which historically have tended to produce armed conflict.

Third, atomic energy has already borne a rich harvest of peacetime uses as a research tool in medicine, agriculture, and industry. Radioisotopes are creating new vistas of research. In biology, they are helping us to understand many things—from the nature of cancer to the proper uses of fertilizers. They aid us in mapping new oil pools, in studying industrial processes, in creating stronger materials, and in producing new synthetics. They are among the chief hopes today that man may ultimately discover the secret of the green plant so that he may utilize the sun's energy in the synthesis of basic carbohydrates from water and carbon dioxide. Young people should become aware of the tremendous value of radioisotopes and the extensive researches now under way with their help. They should not be left with the impression that atomic energy is synonymous with the A-bomb.

Fourth, and perhaps more important even than the bomb, atomic energy holds the promise of a vast new source of peacetime power. In 1951, the experimental breeder reactor at Arco, Idaho, was utilized to generate electricity. Only 100 kilowatts were produced but this atomic powered generator provides a pilot plant in which the numerous problems connected with the production of electrical power from atomic energy can be studied. In 1954, the first atomic powered submarine is slated to make its test run. The age of atomic power is much nearer than we thought even a few years ago.

There are good reasons to believe that atomic power will become a reality in the fairly near future. There is sufficient nuclear fuel in the already mapped deposits of the world to last the entire world, at its present rate of power utilization, and not including the present sources of power such as coal, oil, and falling water, for about one hundred years.¹ Glasstone suggests that the cost of electricity obtained from fission energy will not differ greatly one way or another from the cost of electricity produced with conventional fuels. The Cowles Commission report² considered the feasibility of atomic power at great length.

¹ See Samuel Glasstone, *Sourcebook on Atomic Energy*, Van Nostrand, New York, 1950. Written under the direction of the Technical Information Service, United States Atomic Energy Commission, p. 408, par. 14.131.

² Schurr, Sam H., and Marschak, Jacob. *Economic Aspects of Atomic Power*, Princeton University Press, Princeton, N. J., 1950. Written for the Cowles Commission which was charged with the responsibility of making a thorough exploratory study of the economics of atomic power.

The following facts and estimates from this report are pertinent to the present discussion. A pound of uranium is approximately equal in fuel value to 2.5 million pounds of bituminous coal. Thus, atomic fuel is practically weightless and would cost the same in one part of the world as another because transportation costs would be negligible. The cost of nuclear *fuel* would be extremely low as compared with conventional fuels. Present cost comparisons are \$20 for uranium 235 as against \$7,500 for an equivalent amount of coal in terms of energy output. When capital outlay, plant construction, operation costs, as well as fuel costs were considered together, the Cowles Commission reported the following estimates: As compared with electricity produced from coal energized generators in plants situated at the mine mouth, atomic power would have to be produced at about the lowest estimated costs to compete favorably; as compared with electricity produced from coal-burning plants situated about 500 rail miles from the mine in the United States, atomic energy would compete favorably at the median estimates of cost; in those countries that must import coal over the seas (Brazil and Argentina, for example) atomic power could compete with coal-burning plants at the highest estimates of cost given.

Note what this means. Many nations are power hungry. Both India and China are reported to have but one sixtieth of the per capita power utilization that we have in this country. Furthermore, seventy per cent of their power utilization comes from human and animal muscles. Although adequate power is not the only need of such countries, it is clear that nuclear power coupled with sufficient capital investment and technological know-how might lift these peoples and those of many other nations to a level of self-sufficiency that might spell the difference between freedom and peace or dictatorships and war. After all, the mind is clearer when the belly is full and the hope for tomorrow substantial. The atom can help wage the war for decency, freedom, democracy, and peace. The atom has prodigious power both for good and for evil. This power must be seen clearly by our youth. They must be helped to see how atomic power may help to remove the cancerous poverty that afflicts backward peoples and provides the seed beds for communism and fascism alike. As a weapon of destruction, atomic energy may spell the end of modern civilization. As a weapon against poverty, misery, and oppression, it may become the symbol of a new era of peace and plenty and form a powerful bulwark for democracy.

Atomic energy is a tremendously powerful social force—so powerful that it must be ranked with the two or three most fundamental scientific discoveries in the history of mankind. As in the case of all such fundamental discoveries, it is the education of the people who will use it that will determine what the social results shall be. It is in this setting and with these fundamental facts of the atomic age clearly in mind that the proper role of the science teacher may be found.

THE RESPONSIBILITY OF THE SCIENCE TEACHER

It should be clear from the foregoing analysis that more than the science teacher is involved in an educational program adequate for democratic citizenship in the atomic age. Such a program requires the fullest co-operation and planning of the entire teaching staff (desirably, of course, in co-operation with parents, lay adults, and the pupils in a community). But, as was implied in the foregoing analysis, the science teacher has very definite responsibilities to help provide the young people in his charge with certain understandings and insights that he is best equipped to develop.

He must, first, structure a sound basis of scientific facts about atomic energy, its power, present uses, and promise, in order that his pupils will be equipped to analyze the social, political, and economic issues that grow out of these scientific facts. The scientific facts necessary for understanding such issues are not, of course, the technical details required by nuclear physicists. It is possible to provide the majority of our young people with a real understanding of the controlled release of nuclear energy and of the uses to which this energy is being, and can be, put. This has been adequately demonstrated by science teachers in every part of the country. The selection and organization of these scientific facts for general education must be based upon a mature understanding of the issues that the American citizen will be called upon to decide.

In addition to this general education, the science teacher must, secondly, offer a more rigorous education in the basic sciences for those young people who will enter our colleges, universities, and technical schools and become leaders in the scientific fields and in other areas where scientific knowledge beyond that required for general citizenship responsibilities is necessary or desirable.

In broad strokes, these are the responsibilities of the science teacher in the atomic age. What this may mean in detail must, of course, be worked out under the administrative leadership of the individual schools of the communities of our nation according to the peculiar needs and concerns of each community. The following brief outline of objectives may be helpful to the administrator who wishes more detailed suggestions about the relation of the atomic age to high-school science teaching.

Major Teaching Objectives for Literacy in the Atomic Age³

1. Recognition that some of the most urgent problems facing civilization today stem from, or are made more critical as a result of, the fact of atomic energy.
2. The emotional and intellectual acceptance of the fact that, in a democracy, each individual can and should assist in the development of solutions to the problems of atomic energy control and development.
3. Recognition of the fact that no nation can live in isolation in the modern world.
4. Recognition that provincial attitudes and racial, national group, and ethnic prejudices are threats to world peace.

³ Adapted from *Evaluation Instruments in Atomic Energy* prepared by R. Will Burnett, Lillian Gragg, Willard L. Leeds, George C. Lorbeer, and Allen L. Peek.

5. Understanding of the destructiveness of atomic weapons and recognition of the threat of atomic war to civilization.
6. Recognition that historical conceptions of national sovereignty must be reconsidered in the interests of world peace and unity in the atomic age.
7. Understanding of the imperative need of adequate international control of atomic energy and the major blockages that presently stand in the way of its development.
8. Recognition of the promise of atomic energy for research, power, medicine, industry, and agriculture.

In Order for These Major Objectives to Be Realized the Student Should Come to Understand:

- a. The general principles and theory underlying the source and release of atomic energy.
- b. That there is no "secret" with respect to atomic energy except for engineering details and plant design.
- c. That the basic scientific knowledge has come from men of many nations and was known to all the scientific world prior to 1941.
- d. The possible uses of atomic energy to supplement existing forms of power and current achievements in the realization of these possibilities.
- e. Present uses of atomic energy in research, industry, agriculture, and medicine.
- f. That atomic energy is inevitably ushering in and accelerating great social changes.
- g. The intent and major provisions of the Atomic Energy Act of 1946.
- h. The political implications of the technical possibilities of international control of atomic energy.

For a Continuing Ability to Keep Abreast of the Developments In Atomic Energy the Student Should:

- a. Have a scientific vocabulary pertaining to atomic energy sufficient for intelligent reading of news releases, periodicals, and non-technical government publications.
- b. Be able to examine critically all commonly available sources of information relating to atomic energy and know where such materials may be located.
- c. Have a sufficient background understanding of the historical development of atomic energy and its control so that he will be able to build future understandings upon a firm basis in facts.

The Results of Instruction Should Be Such That the Student Would:

- a. Realize not only that he can participate in the study of the problems of atomic energy development and control, but also that his contributions can be all-important in a democracy.
- b. Have a continuing desire to help others understand the issues and problems involved and to keep informed on the subject.
- c. Actively engage in securing world peace and unity and developing sound domestic policy by participating in appropriate political and educational activities and in the exercise of the ballot.

USEFUL REFERENCES FOR THE ADMINISTRATORS

Burnett, R. Will. *Atomic Energy: Double-Edged Sword of Science*. Columbus, Ohio: Charles E. Merrill Co. 1949. A text unit prepared for the Committee on Experimental Units of the North Central Association of Colleges and Secondary Schools.

Burnett, R. Will, and Hand, H. C. "Educational Implications of the Atomic Age." *Education*. March, 1951. The entire March, 1951, issue of *Education* is devoted to atomic age education. The article cited deals with the over-all job of the public schools in developing needed understandings to cope with the atomic age.

Evans, Huber M.; Crary, Ryland W.; and Hass, C. Glen. *Operation Atomic Vision*. Washington, D. C.: National Association of Secondary-School Principals, N.E.A. 1948. A teaching-learning unit for high-school pupils.

Glasstone, Samuel. *Sourcebook on Atomic Energy*. New York: Van Nostrand. 1950. An authoritative reference of outstanding worth to the science teacher or others interested in the facts of atomic energy. Should be in every school's professional library.

Hecht, Selig. *Explaining the Atom*. New York: Viking Press. 1947. Without doubt the most lucid account of atomic energy and its historical development for the better pupil and average adult.

Schurr, Sam H., and Marschak, Jacob. *Economic Aspects of Atomic Power*. Princeton: Princeton University Press. 1950. The official report of the Cowles Commission.

United States Atomic Energy Commission, *Semiannual Reports of the Atomic Energy Commission*. Washington, D. C.: United States Government Printing Office. These reports cover the unclassified data on atomic energy and give an excellent picture of the extensiveness of the research and utilization of radioisotopes in this country. These reports should be in every school library.

C. Conservation Education

E. LAURENCE PALMER

In this article, Professor Palmer sketches the development of programs related to conservation. In this connection, he points out what he considers to be the promise and the failure of the general science movement. He also comments on the problems of preparing teachers who can carry on a forward-looking program of conservation education. The last half of the article is devoted to a commentary on several of the recent publications and programs of conservation education issued by various states and organizations and by individuals. In closing, the writer provides a selected list of persons who would welcome serious correspondence concerning the problems and possibilities of improved conservation education in American schools.

SCIENCE and science education have contributed to many aspects of education in general. Through the teaching of science we have attempted to train persons to do exact thinking. This was on the assumption that science may develop straight thinking in many fields of human endeavor. We have recognized and do recognize the role of science in the development of technicians in the fields of engineering, medicine, industry, agriculture, and other fields. We have felt and do feel that experience in the realm of science may increase our general appreciation of the environment in which we live. Through this, it may help us to develop a rational behavior in our relationships with our physical,

E. Laurence Palmer has just retired (1952) from Cornell University, where he has served a long and distinguished career in science and science education. On his retirement, Dr. Palmer will continue to serve in his chosen field as director of educational activities for the National Wildlife Federation.

biological, and social environment. This may lead to a more controlled emotional reaction to the everyday problems that come to us as a result of decisions made by the politician, promoter, evangelist, general educator, farmer, and industrialist. The implications of science are far reaching and must be recognized as such early in the citizen's development.

Many mathematics teachers of a generation ago avoided presenting the applications of principles at the end of the chapter in the text because they had to teach so many principles, so many formulas, so many rules of procedure. Recently at Cornell University a commission was formed to determine why so many secondary-school pupils failed to meet the demands for success in becoming engineers. The engineers were unanimous in their convictions that mere knowledge of principles alone, of formulas and their use without understanding of how principles may be applied and how formulas may be used and developed may be an important factor in determining the success of high-school graduates who take up engineering as a profession. Bulletin 49, Number 18 of the University of Illinois, 1951, *Mathematical Needs of Prospective Students in the College of Engineering of the University of Illinois for the Use of High School Mathematics Teachers and of Guidance Counselors* may be taken as a sample expression of some of the thinking that is being done about the role of high-school science as a factor in the training of engineers at the college level. Similar recommendations have been evolved in other university centers. Of course we all recognize that we cannot model a high-school science and mathematics program solely for the purpose of training engineers no matter how important in society the role of the engineer may be.

Science has been recognized as the handmaid of agriculture at many levels. As far back as 1910, F. H. King published *A Textbook of the Physics of Agriculture*, the merit of which was never duly appreciated and much of the teachings of which have been incorporated in our modern general science program. Hunter's series of texts showing the contributions of biology to health won greater public support than did King's effort to tie physics to agriculture. This may be due in part to the fact that health is a universal problem of mankind while agriculture is not. It may also be due to the fact that a book published by a major book publisher offers a greater appeal than the usual book published privately by a college professor.

Our general science movement has of course been a revolt against the emphasis on departmentalized academic science, but it can hardly claim public support if we depend on the record of how it has failed to keep the promises it made at first. To be sure, we probably have more high-school pupils now taking science than was the case when general science was introduced, but the proportion is smaller. General science has not recruited increased enrollment in the specialized sciences as was indicated would be the case when its adoption was originally proposed. And due to some studies that indicated that some progress could be made in some branches of science education by the substitution of the

lecture demonstration for laboratory experimentation, it seems doubtful if general science has contributed adequately to the development of young scientists through direct experimentation in laboratory situations. General science may be considered to have contributed to the concept that science consists of remembering a mass of facts and generalizations without the benefit of supporting significant experiences. It is possible that the two relatively recent yearbooks of the National Society for the Study of Education that dealt with science education may have given some impetus to this philosophy.

There has been some effort on the part of the social scientists and geographers to adopt some of the teachings of science for use in interpreting social science problems. It is almost inevitable that this situation should develop. It does not mean, however, that the use by the social scientists of the teachings of academic science will guarantee the most profitable use of the opportunities possessed by a well-rounded science program. The social science program may be as academic as the science program, and neither may have been developed along functional lines in some situations. Both science and social science may be as inadequate educationally as the basic mathematics of a half century ago.

Attempts to make agriculture serve the whole role of science have naturally failed in urban communities where agriculture is not an immediate major concern of the community. Attempts to make an academic general science serve the whole role have usually failed to give complete satisfaction because applications where they have been made have been almost exclusively outside the realm of the interests of the social scientists. We are members of a human community whether we like it or not.

In the realm of the general education idea that won favor relatively recently, science, if properly integrated, can make a major contribution. It is quite probable that the apparent rise of interest in conservation education that has paralleled the recognition of the importance of general education is to be expected. Conservation deals with broader applications of science than did the affiliation with health ably advocated by Hunter and others. It certainly has a broader implication than we find in King's identification of physics with agriculture or the academic concepts of what constitutes science offered to us by the National Society for the Study of Education yearbook committees.

The great danger in letting conservation, agriculture, industry, health, or other types of educational effort serve as a substitute for the rigorous indoctrination that so frequently identified the earlier science training lies in the danger of superficiality. Shiboleths about soil erosion, pollution, predation, and overpopulation do not necessarily imply understanding based on mastery of soil physics, the chemistry of waterways, biologic balance, or human ecology. We can develop teachers who may present impressive and erudite lectures, but it is difficult to be convinced that these teachers can develop understandings which they themselves do not have. How, for example, can a trainer of high-school science teachers in one of our major universities be expected to do a satisfactory

job when, in spite of the fact that he has a doctor's degree in science education, he has no college credits whatever in geology, physics, chemistry, botany, physiology, or zoology? If he cannot do this for the sciences, how can he integrate something he does not have with other things which he also does not have, judging from his record?

Right here we face one of the practical difficulties of expecting a successful future in the field of conservation education. If we cannot get adequately trained teachers of science, how can we expect to get adequately trained teachers of science who have equal understanding of social science to present an adequate conservation program? The difficulties of the situation must be recognized as a challenge rather than as a discouragement. The penalties to civilization of an inadequate conservation program are such that we cannot afford to abandon a program simply because it presents obvious difficulties.

One of the present difficulties of accepting on a cosmopolitan basis much that is offered us in conservation education is the obvious emphasis of our programs on rural problems. The 1951 yearbook of the American Association of School Administrators on *Conservation Education in the Schools*, for example, suggests as appropriate urban activities the studies of overgrazing and of cultivation of fields contrary to the contour. On page 125 it quotes from Seattle's *Using Our Land Wisely* an excellent philosophy when it says, "An attitude should never be presented as a generalization to be memorized but should be an outgrowth of a child's experience, study, and discussion—the result of inductive study of a situation. Real learning is that which becomes a part of behavior . . . understandings and opinions are barren unless behavior is influenced." This excellent statement fails to be accompanied by suggestions integrated with types of behavior typical of urban life and significant to conservation. The wasting of water in homes, of heat in buildings, of clothing and food in everyday life is ignored for suggestions about cutting off timber, allowing fields to lie fallow, draining swamps, and over-grazing, few if any of which are identified with the normal behavior of an urban youth. Studies are being made in Long Beach, in New York City, and elsewhere to provide a more functional program than can be expected by suggesting that youth "report on the Golden Age of China and on the decline of the Roman Empire, Spain and the Mayas,"—these last appear in the program for the city schools in Waco, Texas.

The 1951 Yearbook of the American Association of School Administrators is a step in the right direction, but may suffer through lack of support because the program suggested in some cases means that conservation is just another subject, not a functional unit of education.

Many educational units have attempted to suggest conservation programs, but few of them identify the activities with science programs to the end that they may be considered as being in any way a substitute for the science offering. *Better Living through Wise Use of Resources*, which appears as Bulletin 1950, No. 15 from the United States Office of Education, for example, gives excellent ex-

amples of what is being done in many parts of the country and suggests many significant generalizations, the understanding of which might be worth while. But it is difficult to recognize in the suggestions much emphasis on the methods of science. The report should be read by science teachers, however, since they may implement the suggestions better than in any way we find in the report.

The *Guidebook for Conservation Education*, issued by the Department of Natural Resources of the State of California in co-operation with the state's Department of Education, emphasizes important problems and suggests many useful sources of help, but it still lacks rich specific suggestions for teachers who want to do something in the field.

The Cornell Rural School Leaflet's *Conservation, a Handbook for Teachers* (September, 1951) is rich in suggestions of things to do, but it is inclined to emphasize matters of an academic nature rather than activities in which youth have a natural interest. Young people like to fish and hunt, to skate and ski, to camp and hike. They are not naturally interested in determining the compactness of soil or how soil erosion starts. We have yet to have published the kind of material that employs their interests to the exploration of their environment in such a way that they will enjoy the experiences which we recognize as part of science and which will result in improved behavior. It is admitted that this will probably, for some time to come, have to be presented in the form familiar to the average teacher.

In Maryland's *Things to Do in Conservation*, published by the State's Department of Research and Education in December, 1951, we find rich suggestions for things to do based reasonably well on situations in Maryland and providing guidance for the preparation of paraphernalia familiar to many teachers. Much of the work is identical with work proposed in science programs and to this extent at least may be recognized as contributing to a science program. However, we fail to find any statement as to whether the material is provided for use in elementary schools or secondary schools, and there is certainly no attempt to propose a continuous program in which initial experiences contribute to the understanding of subsequent activities. Because of this, it is almost impossible to evaluate this offering in terms of a whole school program.

William G. Vinal's *The Outdoor Schoolroom for Outdoor Living* published in January, 1952, through Boston College, is subject to the same criticism given to the Maryland material. It raises questions interminably and suggests specific places where the pupils may find the answers in a natural setting outdoors. It reflects the philosophy of Jackman which appeared in the third Yearbook of the National Society for the Study of Education but puts the program outdoors instead of in an in-door laboratory. It suggests that the program is designed for use from grades six to twelve but avoids indicating how the experiences may be distributed through this period. It can hardly be considered as presenting a program that would touch exhaustively the typical high-school science

program, but it does present material which would enrich that program in the area where it is to be used.

Wisconsin, in its "Report to the People of Wisconsin on the Progress in Conservation Education," which appeared in February, 1952, as the State's Conservation Department's *Wisconsin Bulletin*, attacks the problem in a different way. It emphasizes consideration of the state's agencies that are available for the development of a conservation program in any of its communities. It advocates that each community develop activities typical of the needs of the area and enlist sportsmen, teachers, churches, and businessmen in the program. It is a report on what has been done and cannot be considered as a guidebook or a curriculum.

Texas has issued on March 15, 1952, Research Study Number Twelve of the Texas Study of Secondary Education. It deals with *The Status of Resource-Use Education in the Secondary Schools of Texas*. It is largely a survey of public and professional education opinion regarding the content and method of conservation programs for the state. From the report one gets a picture of how conservation work is being presented in Texas, the assumption being that this should be important in determining what should be taught and how it should be taught. The information should be important to many administrators.

The American Council on Education published on August 17, 1951, its *Guide for Resource-Use Education Workshops*, designed as a report of the activities through workshops of the Committee on Southern Regional Studies and Education. It gives excellent suggestions to administrators who are looking for help and assistance to teachers in service.

A somewhat similar report, presenting sample activities observed in workshops on a nation-wide basis, appeared in Cornell University's *Miscellaneous Bulletin* No. 9 by Helen Ross published in 1951. It is entitled, *In-service Training in Conservation Education*.

A doctoral thesis prepared at Cornell University in 1949 by Emery Will gives a detailed survey of *Conservation Education in the Secondary Schools of the United States*. Much of this material has been quoted in literature by various agencies. The study was based upon personal visitation to schools of most of the states of the Union by a battery of trained observers and to a lesser degree upon correspondence with many schools where visitation was impossible. It gives evidence that there is a wealth of supplementary printed material available for the schools desiring to develop a conservation program at the secondary level and that there is need for further research in the field, for a many sided approach to the subject, and for a realistic appreciation of the importance of using local situations in the development of the program.

In 1950, The National Committee on Policies in Conservation Education issued from Laramie, Wyoming, a *Report on Training Teachers for Conservation Education* which represents the pooled judgments of leaders across the country who were interested in conservation education. It is worth consulting by administrators.

Those interested in conservation education on an international basis should refer to *The Role of Conservation Education in the Education Program of Latin America* published in November, 1951, by the Pan American Union in Washington, D. C. and to UNESCO's 1950 report on its *International Technical Conference on the Protection of Nature*. This last report should be read by all administrators interested in the international implications of a conservation education program.

Such private agencies as the National Audubon Society, the Izaak Walton League, and the National Wildlife Federation have done much to support local efforts for the development of suitable conservation programs. For the year 1952-53, the National Wildlife Federation, Washington, D. C. is supporting fellowships and grants-in-aid programs in many states with funds in excess of \$25,000. Their stamp program is being supplemented with teacher material, filmstrips, and tape recordings that will be welcomed by many secondary-school groups. The workshops, publications, researches, and other services resulting from this program emphasize the use of local materials whenever possible and may be greatly increased in the future.

The National Association of Biology Teachers, with the assistance of a grant provided by the American Nature Association, Washington, D. C., is developing an ambitious program enlisting the services of experienced biology teachers across the country in an effort to find a common ground between biology and conservation, and through evaluation and other techniques to offer recommendations that should result in improvement in the teaching on both areas. This program administered by Dr. Richard Weaver of the University of Michigan is worthy of the support of all secondary-school personnel interested in the teaching of these subjects.

Those interested in an integration of conservation education and science education may find it worth while to enter into correspondence with the writer, who can supply additional printed material beyond that here available. Others who can be contacted for similar help would be the following:

Richard Weaver of the National Association of Biology Teachers, University of Michigan, Ann Arbor, Michigan.

C. W. Mattison of the United States Forest Service, Washington, D. C.

W. G. Vinal of Boston University, Boston, Massachusetts.

Richard Westwood of American Nature Association, Washington, D. C.

Walter Taylor of the National Wildlife Federation, Washington, D. C.

John Baker of the National Audubon Society, New York City.

Olin Capps of the National Committee on Conservation Education and Publicity, University of Missouri, Columbia, Missouri.

Farley Tubbs of the Outdoor Writers Association, Lansing, Michigan.

R. H. Eckelberry of the National Committee on Policies in Conservation Education, Ohio State University, Columbus, Ohio.

Fairfield Osborn of the Conservation Foundation, New York City.

For a viewpoint of the social scientist's concept of conservation one should consult the May, 1952, *The Annals of the American Academy of Political and Social Science* which features "The Future of our Natural Resources." This should en-

rich the offerings in the conservation field of the average high-school science teacher. It points out problems which must of necessity be solved, in part at least, through the teaching of science. It should motivate high-school science and should be a part of any program aimed towards developing the role of science in general education.

On the whole, it would seem that conservation offers the ideal vehicle for sustaining the place of science in general education. It touches us all. It is dependent on social science and on the natural and the physical sciences. It permits and demands the use of local situations and problems. As such, it offers a superior channel through which the behavior of citizens may be improved for the good of all. Conservation is neither a program aimed at hoarding nor one solely designed to put resources into use. It is not solely a problem of man living in harmony with the land, as Leopold has suggested; rather it is a program designed to help man live in harmony with the land and with other men. As such it is science in general education at its best.

D. Science Education in a National Emergency

B. FRANK GILLETTE

In this article, Dr. Gillette identifies science education for civilian defense as a somewhat specialized form of applied science. He delineates this point of view by discussing eight areas of applied science which add up to an effective contribution to education for a national emergency. These include first aid, nuclear energy and its applications, nutrition, sanitation, implications of biological warfare, fire control, possibilities of chemical warfare, and conservation of energy, material, and human resources. The writer also discusses the school's special responsibility in identifying and encouraging special science talent and in developing a generation of young people who are capable of effective problem-solving in the broadest sense. He concludes his article with remarks about the necessity of the science teacher keeping himself and his pupils up-to-date regarding technological developments, particularly military ones, and with the science teachers share in developing emotional balance and sound social attitudes on the part of his pupils during the unsettled times of national military duress.

SCIENCE education does not dwell in a cloistered sanctuary, sheltered from the realities of a confused world. It breathes the air of strife itself and, having helped create a modern Frankenstein, it now must help people to live with it. But what can be done about atomic bomb disasters and survival in the face of such holocausts? Can science teaching rescue children and their parents from the consequences of science applied by a ruthless enemy against civilian areas?

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What is the obligation of science departments and their progress in a national emergency?

Several special responsibilities will be cited, but it must be noted that these appear to differ only in degree from those responsibilities already accepted by forward-looking science teachers throughout America. Such teachers have already instituted programs of *applied* science teaching. They have taught their pupils about first aid, about sanitation, about protection against biological warfare agents, about the control of fires, and about precautions against X-rays and other forms of radiation. A good science program in normal times gives proper attention to these phases of general education. In a national emergency, these topics are simply emphasized a little more than usual. But let us point up—spell out—these special responsibilities in order that science teachers will not overlook them and in order that school administrators may look for them in their schools.

First, there is the obligation for all high-school pupils to be well trained in first aid. This may be the prime responsibility of physical education or some other department in some schools rather than that of the science department, but certainly the science teacher is involved in this vital program. In an emergency such as we now face, first aid emphasis may have to be shifted from treatment of snake bites to a greater attention to the treatment of burns and shock, but, basically, the first aid actions must be carefully *reasoned out*. Why certain first aid measures are taken is often neglected, but this should never happen if the science teacher is a participant.

Second, the science department of the high school should be actively engaged with the whole field of nuclear energy and atomic warfare. One of the most inexcusable facts in science teaching today is our shame-faced admission that *many* high schools are doing *nothing* about this field. Physics courses are still being taught with only a passing glance at the field of radiation; chemistry courses are being taught with only a mention of radioactive isotopes; biology courses are failing to mention the effect of ionizing radiations on living tissues; physiology courses ignore the effect of radiations on blood cells and leucocytes; agriculture courses pass lightly over the vital research being done with carbon-14 and other tagged isotopes.

What *shall* be taught in this tantalizing field? This article cannot treat the subject adequately, but certainly the areas mentioned above cannot safely be omitted if science teaching is to keep abreast of the times. The physics instructor may plead that "there isn't room in my course to add anything else," but the high-school administrator will recognize this as a symptom of education at its most lethargic level. A vital curriculum *always* has room for what is needed in a changing, evolving world. Of course, when some things are added, others must usually be dropped. Most science courses contain material which could be deleted! Within any one of the high-school courses, there is room for treatment of several of the fields of nuclear energy and study of atomic explosions. In

fact, this writer knows of one chemistry teacher who began his course with a study of atomic energy—and claimed greater interest and greater perception of the principles of chemistry than he had ever attained through a more classical approach.

Third, the science program must give greater attention to the field of human nutrition. These are times of more and more stress upon human beings, and the strength of our bodies may well be a deciding factor in our survival. Americans know a great deal about nutrition, and yet they practice it so poorly. Is there really any excuse for a high-school graduate who doesn't know and doesn't practice good eating habits? Why, for example, should American youth display such ignorance about the value of protective foods? Why should we over-eat so much? Why should we be so little concerned about diets too heavy in carbohydrates? Why should we rely more and more upon drug-store vitamins? Isn't our science teaching program falling down when our high-school graduates show an unawareness of basic nutritional knowledge? Is it a matter of poor teaching of this knowledge and these habits, or is it one of quickly passing by this vital field of applied science—or is it both?

Fourth, we have hardly scratched the surface in this country as regards sanitation. Most of us who live in urban surroundings depend upon modern plumbing to carry our human wastes away from us and have really forgotten the elementary facts about contamination from such wastes. What if an atomic explosion forced the evacuation of a modern city and necessitated the crowding together of thousands of people in temporary shelters? Would we know how to provide for sanitation precautions under such conditions? Do our high-school science graduates really understand about typhoid and dysentery and cholera and how to guard against them? And closely related to sanitation is the problem of guarding against infection. Do we really understand contagious diseases? Suppose an atomic explosion were to contaminate the water supply of a densely populated area? Would we understand how to guard those who did not receive lethal dosages of this radiation from infection to a degree not necessary in ordinary circumstances? Is it generally recognized that radiation destroys vast numbers of our white blood cells, our natural defenders against infection? What actual steps can be taken to minimize dangers of infection?

Fifth, what are we teaching our high-school youngsters about the truths and fallacies of biological warfare (BW)? Are all of the stories to be believed? Could an enemy really destroy our livestock and our crops, as well as whole civilian populations? How could we tell if we were subjected to an attack by biological warfare agents? This is a subject which belongs in every biology course, but is it included in your high school? If it isn't, why isn't it? The Federal Civil Defense Administration has distributed thousands of copies of a bulletin which deals with this subject and much has been written about the subject for several years. Our high-school pupils should know the facts—or else they may not be able to stem panic conditions which conceivably could arise in times of a real national

emergency. A good biology class would do research in *Life*, *Reader's Digest*, and *Colliers* to bring together the facts about BW. The local veterinarian is prepared to discuss the impact of certain BW agents on livestock; the local agriculture agent is glad to discuss the effects on crops of certain potential agents.

And, *sixth*, let us get really practical and discuss fire control measures for a moment. A good science education program should produce pupils who know how fires are started and how they are put out. In times of wartime disaster in a civilian-populated area, many fires will be burning simultaneously and they must be put out by civilians—many of them by boys and girls of high-school age. Do they really understand that water puts out a fire by a cooling action and that use of water *spray* in most instances is more effective because more water is evaporated and therefore more cooling results and, therefore, more control is possible?

This is such a simple understanding, but how well is this concept developed by our science programs? And then there is the matter of chemical fire extinguishers. Does the chemistry instructor make sure that his pupils know why a carbon tetrachloride extinguisher is effective against electrical fires but should be used with great caution when fighting fires in close, confined quarters? Can every senior boy and girl operate a soda-acid fire extinguisher? And what is an incendiary bomb and can a person extinguish one? Many a good chemistry lesson can be built around thermit and napalm and magnesium bombs.

Seventh, what are we teaching about the many agents of chemical warfare? What is nerve gas and what is its effect on the human body? How is it similar to DDT in its action? This subject has many interesting lessons for physiology and biology, and interesting applications can be made in general science. Why is a persistent gas potentially more dangerous in a section where temperature "inversions" are common? What conditions will help disperse a war gas? The use of gas masks and their actions can be brought to play in chemical warfare and one can see the many ramifications into the various fields of science. Again, whole lessons can be built around this "national emergency" curricular topic.

And finally, as an *eighth* item, we must return to that perennial catchword "conservation." In peacetime, in normal conditions, conservation education has gained the solid support of many science programs. In an emergency, conservation becomes even more vital. High-school graduates must acquire the habits of conserving their natural resources, for our very survival may depend upon a wise husbanding of minerals, forests, water, soil, and human beings. We are not too far removed from World War II to have forgotten the great drain on all of our resources, but, unless we practice conservation much more wholeheartedly than we have ever done before, we may be in short supply of those elements we need so badly. But, a high-school principal asks: "What can high-school pupils do about conservation?" One answer is given in the program now being carried out in Portland, Oregon, where nine high schools are engaged in reforesting a small part of the appalling Tillamook Burn. This is conservation in

action. Who knows about the length of the present national emergency? We may be entering a twenty-five year period of emergency conditions; this would certainly demand our very best conservation practices.

And so we have examined eight important areas of curriculum and have seen their relation to our emergency: first aid, nuclear energy and atomic explosions, nutrition, sanitation, biological warfare, fire fighting, chemical warfare, and conservation. The science education program must involve itself in each of these areas in rather fundamental ways if we are to play our rightful roles in this national emergency. The working out of units in each of these areas could be one of the most stimulating experiences which a science department staff could enjoy. Every one of these areas is interesting and has provocative elements to enliven every school science course.

But there is another phase of science teaching to be recognized. The above eight curriculum responsibilities are pointed to general education—to *all* of the high-school pupils. There is a special responsibility in this national emergency in the preparation of certain specialists who will play key roles of a *technical, scientific* fashion. It is in our high-school chemistry, physics, biology, and physiology courses that good fundamentals will be taught to those boys and girls who have the abilities and interests to prepare for professional careers as engineers and scientists. This is a responsibility which today must be magnified for science teachers. America and the world needs many qualified men and women with strong science backgrounds. Some of them will be associated with military endeavors, while others will contribute to civilian economy, but with neither can we afford to be in short supply. Our high schools have a clear cut duty to get them started on their educational paths—taking care, of course, that they help their charges to see the forest as well as the tree immediately ahead of them. *General* education insights first and then specialization is demanded, not the chemist who can synthesize a new chemical but cannot use a fire extinguisher.

From the first time that science teachers started describing their objectives for their principals or supervisors or professors of education, they have listed well in the forefront one which goes by various titles: "problem-solving skills," "use of the scientific method," "critical thinking," "use of intelligence and reason," or choose your own variation. In a national emergency, when thinking tends to become even more confused and when emotions too often take the place of reason, this objective seems doubly imperative. Science teachers can do a great deal in helping their pupils think clearly on crucial issues. We don't want to produce a nation of unthinking citizens who act on the basis of prejudices and who do not search for facts when they are called upon to help make decisions. We want clear thinkers, people who know how to resolve issues, how to solve problems—how to use the scientific method, if you please. Can this be accomplished in science classes? Not entirely there, we hasten to admit, but certainly the science department has no alibi if it neglects this task. Every science teacher and every principal should read R. Will Burnett's new monograph, *Combating*

Prejudice through Science Teaching, published by the National Science Teachers Association. This includes useful suggestions on this subject for teachers of science.

And finally, we must discuss briefly the impact of military mobilization upon high-school pupils. Science teachers must face this reality in several ways. In the first place, they must acquaint their pupils with the new military gadgets as they are publicized. What is the principle of the submarine Snorkel? How does radar work? What is meant by supersonic detection? High-school boys and girls must not remain sheltered and ignorant of these newer devices and others as they are revealed.

But in addition, for a high-school pupil—a boy in particular—to live with the reality of military mobilization, it is demanded that he develop an emotional balance, a serenity to live under such conditions of insecurity. Mental hygiene is not the peculiar province of science education programs, but the contribution of the science teacher is required along with others. Somehow, the high-school principal must see that all of his teachers, implemented by actual teaching activities in science and social studies classes, will come to grips with this problem. The development of healthy, forward-looking, optimistic youth who understand how they are involved in the solution of our problems is the responsibility of all teachers, but the role of the science teacher may need to be "spelled out." If the history teacher helps youth to understand the tortuous but positive progress from barbaric times to more humane times, the science teacher can develop belief in the contributions science has made to better living. For every destructive agent of biological warfare, there is an anti-biotic for the cure of sickness. For every atomic bomb, there is a clinic where radium or cobalt-60 can alleviate suffering. For every B-36 bomber there is a strato-cruiser which helps man to conquer space. Yes, science teachers and other teachers can help the graduating senior understand that the world is not entirely military and that he is not dedicated to a war machine. They can help him develop the set of values which he needs in troublesome times. Americans must remain optimistic about the future.

Such is the role of a vital science education program in this national emergency. It is not an easy role to play and not every science teacher or every science department will play it in the years ahead. Most of them will, though, and through them we know that we can survive to happier days. As a busy high-school principal, will you add this extra job of helping your science teachers play this role the way it should be played?

E. America's Need for More Scientists and Engineers

MAYNARD M. BORING

MERRIAM H. TRYTTEN

In this article, the writers point out the existing demand for trained scientists in many fields of specialization. They also identify the reasons for this demand and provide challenging examples of present and future needs for scientific personnel. In spite of this increasing demand, enrollments in science specialties are suffering. The latter portion of these pages is devoted to the role which high schools can play in meeting this need for scientists. The writers provide specific suggestions for high-school activity in three general categories: (a) identifying young people with unusual interest and talent in science, (b) encouraging potential scientists, and (c) providing individual attention and opportunity for early specialization and broad background for those who may specialize in science.

MUCH has been said recently about the need for additional persons trained in the fields of science and engineering to carry on the vast programs of research and development and production in which industry and the government are now involved. It has now been recognized that the demand for personnel in these fields of training is so great that there must be, in the future, a co-ordinated effort on the part of secondary schools and higher education to identify and to train persons who give evidence of the necessary aptitude and competence in these fields.

The present demand is a direct result of the tremendous technical development of the past fifty or one hundred years. It was approximately one hundred years ago when the first significant efforts were made to bring the discoveries of science into use in the home and in the market place. While the steam engine and mechanical looms are somewhat earlier in origin, the real beginning of industrial technology can be thought of as stemming from the creation of such industries as the communications and electrical industries, particularly in the past one hundred years. The rapidly increasing use of power in our factories, the development of motor cars and the airplane, as well as the tremendous advances in rail transportation during the first half of this century have cut down barriers of space and have increased the productivity of the worker to an unprecedented extent.

Completely new industries have been established and have grown to great magnitude. One of their characteristics is the development of industrial labora-

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ories which have persistently exploited scientific phenomena for the improvement of industrial products and the creation of new ones. The speed of this development has been remarkable. There are probably more industrial laboratories today in the United States than there were holders of a doctorate fifty years ago. Since the war, this movement has accelerated very rapidly due to a number of factors.

The great stimulus to scientific research during the war has resulted in many scientific discoveries which are becoming a part of industrial technology, and the whole new field of nuclear technology has been added since the war. The very large program of research and development for military purposes is a post-war phenomenon.

Again, the technical assistance programs of the United States seem quite likely to require substantial numbers of scientifically trained personnel in foreign service. Dollars alone will not build adequate defenses abroad. We must also lend much technical help to our allies in Europe, in southeast Asia, and in other lands. This will place the added burden of preparation of still more technically and scientifically trained manpower on our educational system. We cannot carry the load of the entire world in providing adequate weapons for defense, but we must at least be willing to contribute our knowledge and experience in the future development of agriculture and in the utilization of power abroad. We must assist in the advancement of science and engineering and supply certain numbers of these professions particularly to those areas where primitive methods are still being used so that those people can improve their standards of living and, in the ultimate, can at least approximate our achievements.

While this great expansion of activities requiring scientists and engineers has been taking place, there has been a reduction of enrollments in colleges and universities in these specialized branches over the past four years from the peak enrollments of two years ago. While some of this decrease is due to the passing of the "G. I. Bulge," there appears to be evidence that future graduating classes will at least be no greater than those prior to World War II.

We are faced, therefore, with ever-increasing demands for more personnel with substantial technical training and an apparent decrease in the oncoming supply. This is the problem which faces the educational institutions of the United States. It appears quite certain that, if this problem is to be met adequately, the secondary school must play an important part in the re-examining of their courses and their practices so that those who are qualified and interested in the fields can and will secure the training which will make it possible for them successfully to enter upon and complete college courses of training in their chosen field of technology.

And what can the administrator do to promote this kind of activity in his school system? The high school's role in producing tomorrow's scientifically trained personnel may be thought of in three major phases—identification, encouragement, and opportunity.

Obviously not all high-school pupils are equipped, either by intelligence or attitude, to specialize in professional endeavors related to science. But there are many on the secondary-schools' rolls who are so qualified—they *must be found*. Many reliable tests of achievement, aptitudes, and attitudes are available which can help alert school systems locate this gifted minority of young people. Alert teachers in many subjects, particularly science and mathematics, can also aid a great deal in this essential identification of potential scientists. Evidently this task is not one for the science teacher alone, but one in which many educators can co-operate; the instigator and co-ordinator of this function may well be the school principal.

Once potential science talent has been located—and also while it is being sought—young people can be encouraged to give careful consideration to a science-related career. This is not intended to imply that youngsters must be coaxed or cajoled into this kind of preparation. However, there are many who do have the talent for such a career who will not enter it because of misconceptions about its difficulty, its hardships, or its liabilities. Thus the job of "selling" a career in science becomes one of providing adequate information so that young people can make their choices on the basis of facts rather than on the basis of prejudices and misinformation. In many cases the most valuable thing for a pupil to do is to arrange his school program so that a future and more definite choice in the direction of science will not be rendered impossible. For example, if a science-talented pupil is persuaded to select a high-school curriculum which permits easy and well-prepared entrance into college, the possibility of the choice of a science-related career is thus preserved for him for a few more years.

This encouragement of science-talented youth can be accomplished in many ways. Extraclass activities of sufficiently wide scope, state and national science talent searches, school and community science fairs, opportunities for science-related field trips and extended excursions, and a science program which permits adequate attention to individual differences among pupils all have their contribution to make toward this function. Again it is evident that the task is impossible without the support and encouragement, and often the active participation, of school administrators.

Even when science talent has been located and its fortunate possessors have been enthused about their futures, they must be provided with the opportunity for the necessary preparation. This takes two important forms, one academic and one financial. The school can do its share by providing courses which will not only serve the future-citizen needs of all pupils *including the prospective science persons*, but will also permit possible science specialists to gain the additional education they need. Here, too, a rich variety of extraclass activities and attention to individual differences among pupils can be of real value. Schools would also do well to organize college visitation days in which college-bound youth—science specialists and otherwise—can get a preview of what is expected of them.

Most high schools are not in an advantageous position to supply financial aid for the special education of science-talented pupils. However, schools can help pupils to locate some of the numerous scholarship possibilities, and can in other ways help the youngsters to help themselves. Indeed, it is quite possible for the school to stimulate the local community—its industries, its businesses, its philanthropic organizations—to provide financial help for needy pupils with special talent. Once more it is evident that the administrator has a key role to play in providing science-talented pupils with the opportunities which human rights insist they should have and which a science-hungry society demands they be given.

There is no need here to hide the school's responsibility behind a cry of "favoritism" or "undemocratic practice." Our concept of democracy calls for giving to each person the opportunities for which his talents and his attitudes are suited. Within this framework we provide special equipment, instruction, facilities, and motivation for athletic ability, for talent in music and drama, aptitudes in journalism, and the like. It is certainly no stretch of this concept also to provide special opportunity for those who are talented in fields related to science and other academic fields.

This role of the school in providing scientific personnel in the coming generation—these functions of identifying, encouraging, and providing opportunity for the pupils with unusual scientific talent are not only the responsibility of the science teacher, although he plays a strategic part. The task involves others in the school system, particularly mathematics teachers and guidance personnel. A substantial background of mathematics is essential in most scientific pursuits related to the physical sciences, such as engineering and numerous other occupations which involve science. Guidance counseling could well be increased, particularly in the junior high school, so that our young people can obtain the necessary preparation in fundamentals to attain their goals. Entirely too few are taking these fundamental courses. And woven through the efforts of all these is the support and co-operation of the school administrators.

If we are to survive and to retain our leadership, our younger generation must be given the incentive and the opportunity to prepare themselves for the social, production, and military obligations which they will surely face in the scientific age in which they live.

The Book Column

Professional Books

Art Education in a Scientific Age. Kutztown, Penna.: Eastern Arts Association, State Teachers College. 1952. 112 pp. \$3.00. This volume presents points of view, activities, and methods consonant with the times. In it the reader will not find ready-made answers to problems posed by our scientific age; rather, he will be stimulated to engage in further personal search for those solutions that will best meet his needs, in terms of the children and youth that come under his direction at this, the most crucial epoch in western culture. Part I includes three of the major addresses delivered at the 40th convention of the Eastern Arts Association at Atlantic City in April 1952. Parts II and III include the official report of the Association's activity and business. The directories alone make the book valuable to those interested in art education.

Bases for Effective Learning. 31st Yearbook. Washington 6, D. C.: Dept. of Elementary School Principals, NEA, 1201 16th St., N. W. 1952. 390 pp. \$3.00. Members of the profession examine in 47 articles what constitutes effective learning and teaching in the elementary school. The purpose of the yearbook is to promote understanding as to what underlies and buttresses effective learning and teaching procedures. Winifred E. Bain, president of Wheelock College, Boston, Massachusetts, points out that today's educators know more than ever before about child growth and development but that they do not always put this knowledge into practice. "We shall do as well as we know" she claims, "when we genuinely respect children as individuals, when we have an intelligent appreciation of social processes in human relations, when we prepare children for the uncertain future by helping them with the processes of learning and by keeping the zest for learning alive."

BURCKEL, C. E., editor. *College Blue Book.* Seventh edition. Yonkers-on-Hudson, N. Y.: Christian E. Burckel and Associates, P. O. Box 311. 1952. \$8.00; a \$7.50 special price is offered if payment accompanies order. This book contains information gathered and compiled from nearly 5,000 detailed questionnaires, returned by as many university and college registrars, from personal interviews and from thousands of published catalogs, cross-checked with Federal and state government statistics and prolonged institutional correspondence. It contains quick basic information about the world's institutions of higher learning. The editor has conferred with university and college officials; read the catalogs; obtained accreditations; grouped schools by types, locations, and sponsorship; and otherwise have saved the reader time and trouble in choosing proper establishments. It is a work that performs its special service by bridging the gap between the statistical digest and the dressed-up prospectus. All data appear in a single horizontal line on one double spread of two opposite pages. The rest of the book consists of cross-references to the main body of tabulated information, grouping the institutions by types and categories, sponsorship, affiliation or control, and many others. In it will be found all colleges and universities, all junior colleges, all technological institutions in the United States, Canada, and the rest of the world. As in previous editions, this seventh edition has been "still-bettered" in response to suggestions from the field. It has larger pages that permit the presentation of all salient facts about a given school in one place, and with other useful improvements, that include a listing of institutions controlled by or affiliated with religious groups and a list of academic degrees, the curricula time for attaining them, and their ranking importance.

CRARY, R. W., editor. *Education for Democratic Citizenship.* 22nd Yearbook. Washington 6, D. C.: National Council for the Social Studies, NEA, 1201 16th St., N. W. 1952. 173 pp. \$3.00, paper covers; \$3.50, cloth bound. It is clear that education for democratic citizen-

ship is not solely the responsibility of social studies teachers; it should encompass the entire school program and permeate all aspects of school life. Even beyond that, the responsibility extends out into the community involving numerous community agencies, the home and the church. The total task of education for responsible citizenship must involve all these forces in a co-operative team if our goal in preparing a loyal, informed, and effective citizenry is to be realized. This yearbook does not attempt to deal fully with all the ramifications of such a total program. However, it does attempt to pose a broad definition of citizenship and to imply a good deal more than narrow curriculum approaches to the problem. At the same time it has been prepared with the specific audience of the social studies teacher in mind. Although the yearbook is addressed to social studies teachers, it should be of interest to all school personnel and citizens concerned with this fundamental area of living in a democracy.

HARAP, HENRY. *Social Living in the Curriculum*. Nashville, Tenn.: Division of Surveys and Field Services, George Peabody College for Teachers. 1952. 142 pp. (paper covers). \$1.00. This monograph originated in a desire to test the idea of *social living* in the crucible of practice. The author visited many widely distributed classes which devote a large block of time daily to an ongoing project in current social living. Part I gives the general characteristics of *social living* or the core, and Part II reports the work of each grade separately. The study covers all twelve grades in the belief that a common thread of good living runs through all the successive years of school life. The study should interest those who are pioneering in co-operative learning and those who may wish to experiment with a core curriculum.

KINNEY, L. B., and PURDY, C. R. *Teaching Mathematics in the Secondary School*. New York 16: Rinehart and Co. 1952. 397 pp. \$5.00. The prospective teacher of mathematics must have a thorough understanding of the principles of the subject, but this qualification is not sufficient. The good teacher seeks first of all to understand the interests and abilities of his pupils, after which an environment is created in which learning may take place. Within this environment the competent teacher becomes a dynamic agent in facilitating the learning process. Although some gifted persons are acknowledged to be distinguished teachers even though they have received little or no professional training, it is true generally that successful teaching requires a serious study of the learning process and its implementation.

The authors of this book have spent many years analyzing the applications of modern principles of educational psychology to the teaching of mathematics. This analysis has involved, in part, an examination of the techniques and purposes of many master instructors of the subject. As a consequence, this book should be a valuable source of reference and inspiration for both prospective and practicing teachers of mathematics.

The teaching of mathematics presents unusual difficulty among the various subject fields in view of the fact that mathematics by definition is deductive, whereas the learning process in general is inductive. Many teachers appear not to understand this distinction; yet it is the most important single factor to be considered in the development of effective teaching procedures. The authors give fundamental recognition to this important difference between the subject taught and the manner of teaching it.

The new teacher will welcome the detailed treatment of classroom practices that this book contains. Even veteran teachers will find a great deal of information in the treatment of tests and in the discussion of visual aids. The authors recognize, in a realistic manner, the varied roles that mathematics must occupy in the curriculum; that is, each course must clarify what has preceded, it must anticipate what will follow, and it must always become enmeshed in the total program of education for life in a complex world.

LANDIS, P. H. *Adolescence and Youth*. Second edition. New York 36: McGraw-Hill Book Co. 1952. 473 pp. \$5.00. This second edition is based on the belief that adolescents and youth in today's society experience difficulty in attaining maturity primarily in three fields—moral, marital, and economic; and that their problems grow out of the difficulties

which modern society has created for attaining maturity in these fields. Emphasis is shifted from the physiological to the sociological and psychological. The author feels that there is too little understanding of the fact that experience is more than a function of physical maturation and inherent disposition; too little understanding of the impingement of the social process on the developing organism; too much emphasis upon adolescent youth as a state, a period; too little upon it as a dynamic process which leads the growing psychological organism through a molding series of social experiences. The perspective of adolescent-youth interests is recast; and quandaries, conflicts, and perplexities are treated as a reflection of the complexity of social structure in which youth grows to maturity in the twentieth century. The thesis is that the emotional turmoil reflects a sociologically inspired condition, not a biologically induced state.

Recognizing not one social world but three, the book treats the problems of adolescence and youth in urban, town, and rural society. Case histories are presented; statistical data are given in graphic and pictographic form. The book covers the age range from twelve to twenty-four, rather than just the high-school age, since no part of the span can be understood when it is isolated. There is a comprehensive analysis of educational problems in relation to the social forces that affect the development of youth. Applications are made to problems of school, church, and home. There are far-reaching implications regarding high-school and college administration, teaching training, and the development of new institutions designed especially for the youth group. Questions, problems, and references have been provided at the end of each chapter.

LARSON, L. A., and YOCOM, R. D. *Measurement and Evaluation in Physical, Health, and Recreation Education*. St. Louis: C. V. Mosby Co. 1951. 507 pp. The place of measurement and evaluation in an educational program is established, in this text, by relating measurement and evaluation to the other eight functions of education; namely, interpretations, objectives, social organizations and auspices, programs, leadership, history and trends, administration, and professions. It is further emphasized that measurement and evaluation are a tool—a means to an end, not an end in themselves. This text will aid in the improvement of the measurement and evaluation programs so that practices in the selection, construction, application, analysis, and interpretation of techniques used to gain information about the product and process of education may be made in the light of the total purposes of education as partially accomplished through the programs of physical education, health education, and recreation. Chapters I and II establish this objective. Chapter III (Cardiovascular-Respiratory Functions) presents the most simplified techniques for the measurement of the circulatory-respiratory basis of performance, which border on laboratory techniques. Chapters IV through VII present measurements gained by external performance. Chapter VIII (Physical Fitness) presents an over-all index of performance with a central reference to organic functions. Chapters IX and X deal with the measurement of motor skills; Chapters XI and XII, with the measurement of knowledge and understanding, Attitudes and Practices; Chapter XIII, with individual adjustment to animate and inanimate environments; Chapter XIV, with the evaluation of program operations and the factors in the conduct of programs; Chapters XV, XVI, XVII, and XVIII deal with the statistical tools of measurement and evaluation; while the concluding chapter deals with the administration of the program of measurement and evaluation.

McGEHEE, FLORENCE. *Please Excuse Johnny*. New York 11: Macmillan Co. 1952. 242 pp. \$3.50. With a warm heart for the luckless child and a clear insight into his problems, the author tells of her experiences as a "hookey cop"—truant officer if you prefer—in a fruit-raising California community. This book is the story of children who could not come to school or did not want to come to school: who knew more about life than teacher, or who found themselves frustrated by circumstance. To some their escapades brought tragedy; some went their merry way; some were reclaimed by the author's kindness and understanding.

In attempting to get her truants to school, the author had to learn how to handle the vicious, the subnormal, the rebels, and the many denizens of fly-by-night trailer camps. The parents of these unfortunate children—Gypsies, Mexicans, Okies, Indians—wanted "Johnny" out in the fields earning money, and they looked suspiciously upon anyone who wished to take away an important source of the family income.

MEIER, A. R.; CLEARY, F. D.; and DAVIS, A. M. *A Curriculum for Citizenship*. Detroit 1: Wayne University Press. 1952. 425 pp. This book reports aspects of a five-year pioneer study of education for citizenship in selected Detroit public schools. This first book of the study demonstrates the needs for such a curriculum, explores program possibilities, and tests them in the schools. The primary concern was that of seeing whether desirable changes could actually be put into practice in the participating schools. Those conducting the study were not solely interested in finding out what was wrong with current citizenship education programs and then in making recommendations; they preferred to determine the need for change and then attempt to get the needed changes into actual school practice.

The staff members of the study worked with the school faculties on a co-operative basis. Each school was expected to strive for improvements in its already existing citizenship program; each school was to be autonomous. The study was committed to the principle that each of the schools was different and that this difference was to be honored. Consequently, though central staff members tried to stimulate citizenship activities, each school determined the nature of its own program and the extent of its participation in the study.

Two aspects of this co-operative method were emphasized: working on problems that were important to a school and encouraging widespread faculty participation. At all times, efforts were made to ascertain the school citizenship problems that seemed important to teachers and then to work toward the solution of those problems. Frequently this required deepening of insights, obtaining different viewpoints, and acquiring new information until the solutions were found or the problems themselves were redefined. Faculty participation always received a major emphasis, but participation by children, parents, and community leaders constantly increased during the study. Basic, however, was the attempt to enable teachers to share in the development of the school's citizenship program.

The three authors of this report worked closely with participating schools throughout the five years of the study. They saw the study start, develop, and end. They worked patiently and co-operatively with teachers on difficult problems. During the last two years of the study, by staff agreement, they concentrated their efforts with four of the participating schools. They have had a personal, intimate relationship with the faculties of these schools. From this rich experience they have written an account of the study efforts to improve the citizenship programs of these schools. They have described the development of the study, the methods employed, and the areas included in the citizenship curriculum.

MIEL, ALICE, and ASSOCIATES. *Cooperative Procedures in Learning*. New York 27: Bureau of Publications, Teachers College, Columbia University. 1952. 519 pp. \$3.75. This is a practical new volume—one which teachers, curriculum workers, education students, and administrators will find helpful. They will find it a resource because it reports scores of actual experiences of a group of experimentally minded teachers trying to develop more skill in working co-operatively with their pupils. Many of the reports include complete verbatim records of group planning sessions, with analysis and appraisal of the methods tried and of their results presented in parallel columns. Underlying this action research were three basic assumptions: the school is responsible for developing an understanding of the nature of co-operative procedures and for teaching the skills involved; learners should participate in determining the purposes to which they will work; knowledge is of little value unless it is related to action. Group procedures properly used are an unusually effective bridge between knowledge and action.

Thus, co-operative procedures were seen as skills to be learned and, at the same time, as a method of increasing the quality of all learning. Based on the firsthand experiences of many teachers, this report highlights the teacher's role in helping pupils to plan co-operatively. Specific help is given on such trouble points as these: How do you get started? What about preplanning? How do you secure wider participation and a higher quality of discussion and planning? How do you distribute chances for leadership? What do you do about planning in small groups? How do you guard the rights of the individual? How do you evaluate what you achieve? The report also presents generalizations on the principles and techniques involved in increasing teachers' skill in using co-operative procedures and conditions under which pupils of various ages, levels of intelligence, and backgrounds can have rewarding experiences with group work.

MILLETT, J. D., editor. *An Atlas of Higher Education in the United States*. New York 27: Columbia University Press. 1952. 60 pp., (11" x 14", paper cover). \$2.50. Simply and clearly designed, this atlas consists of a series of 61 maps of the states and of the large cities in the United States, showing the distribution of 847 universities, liberal arts colleges, teachers colleges, technical schools, and general professional training schools—public and private. The wide diversity of institutions of higher education is graphically illustrated. The author points out in his introduction that three quarters of our population live within thirty miles of some institution of higher learning. Complete population facts and figures, state by state, reveal both the extent of higher education in each state and the places where gaps exist. This reference, with its easy-to-obtain information, is invaluable for all who need to know the location and distribution of institutions of higher learning throughout the United States. The atlas is the third in a series of reports and studies by the Commission on Financing of Higher Education, sponsored by the Association of American Universities.

PETERSON, A. D. C. *A Hundred Years of Education*. New York 11: Macmillan Co. 1952. 272 pp. \$3.25. Whether as parent, as teacher, or as pupil, everyone of us becomes sooner or later involved with some department of the current educational machine, and nearly everyone seems to have theories about how it might be altered and improved. This survey covers developments in primary and secondary education, universities, technical education, women's education, adult education, and educational psychology. The author uses a comparative method by which developments in Europe and the United States are followed at the same time as those at home.

The Teacher of the Social Studies. 1952 Yearbook. Washington 16, D. C.: National Council for the Social Studies, NEA, 1201 16th St., N. W. 1952. 256 pp. \$3.00, paper bound; \$3.50, cloth bound. This publication is divided in three general divisions. The first division is a consideration of the responsibilities and challenges associated with successful teaching in the social studies. The second division is concerned specifically with pre-service education and points clearly to the need for re-examination of existing programs for the preparation of college teachers in social science programs. The social studies teacher at work is discussed in the third division. Its purpose is to suggest ways to assist the beginning teacher on some of the problems he may experience in his initial contacts with teaching, as well as to suggest ways in which an experienced teacher can further his own in-service growth.

Viewpoints on Educational Issues and Problems. Philadelphia: University of Pennsylvania. 1952. 390 pp. (paper cover). This is the proceedings of the thirty-ninth Schoolmen's Week held annually at the University of Pennsylvania each April. This meeting was a joint meeting with the Southeastern Convention District of the Pennsylvania State Education Association and was held on April 23-26, 1952. It contains the lectures and discussions presented at this meeting. These presentations are organized as follows: Part I, Administration; Part II, Elementary Education; Part III, Comparative Education; Part IV, Radio and Television Education; Part V, Science; Part VI, Secondary Education; Part VII, Teacher Education; Part VIII, Trade and Industrial Education; and Part IX, General Topics.

WAHLQUIST, J. T.; ARNOLD, W. E.; CAMPBELL, R. F.; RELLER, T. L.; and SANDS, L. B. *The Administration of Public Education*. New York 10: Ronald Press Co. 1952. 611 pp. \$6.00. This volume combines theory with practicality and realism in covering every phase of modern, forward-looking school administration. Useful as a field manual for superintendents in service, it stresses the best methods for handling dozens of on-the-job problems. Emphasis throughout is on ways of implementing the democratic philosophy of education in administration practices. Step-by-step guidance, many helpful suggestions, and illustrations form a part of this book.

Books for Pupil-Teacher Use

BASSECHES, NIKOLAUS. *Stalin*. New York 10: E. P. Dutton and Co. 1952. 384 pp. \$4.75. It is on one man—Joseph Stalin—whom the eyes of the world are turned today. The whole development of Russia since the death of Lenin is closely bound up with Stalin's personality. Anyone who wants a clear picture of the Russia of today must first gain a knowledge of Stalin. For these reasons, the author, well known for his articles on Russia during the war years and one of the best informed experts on this side of the Iron Curtain, decided to publish the material concerning Stalin which he has been collecting for many years. Not only does he depict the man, his character and his career, but he also lays bare the roots from which this Stalin sprang. He emphasizes the influence that Stalin's background had in shaping his policy, an influence still evident in his attitude towards Russia and her place in world affairs today. Here is shown how Stalin, though master of his fate, has come to be dominated by his own success.

BIEGELEISEN, J. I. *Careers in Commercial Art*. New York 10: E. P. Dutton and Co. 1952. 255 pp. \$4.00. This new, revised edition, is up-to-date in every detail, with salaries for typical jobs both for beginners and established artists and technicians, and with one entirely new chapter containing heretofore unpublished material on the role of commercial art in television, including scenic design, painting, and special effects. The author states the scope and purpose of his book as follows: "The man or woman engaged in art for commerce and industry in our country today must be a specialist in a particular phase of this large field. The complexities of our industrial and professional set-up demand specialization. This book is intended to show the various art careers that are based on specialization. I hope it will contribute towards a wider appreciation of the many careers that are directly related to art and industry."

BILLINGS, HENRY. *All Down the Valley*. New York 17: Viking Press. 1952. 208 pp. \$3.50. This book is geography, engineering, history, economics, sociology, and a combination of all five. It is "a book about water and people." The water and people in this case are those of the whole drainage basin of the Tennessee River and its tributaries: a region of forty thousand square miles, involving seven states. The author follows the history of this region from the year 1779, when a group of courageous pioneers, led by Colonel John Donelson, floated down the rivers, through two hundred miles of wilderness, to join a new settlement at French Lick.

He shows how the Tennessee Valley Authority, created in 1933, planned and worked to change this situation. Its purposes were: (1) flood control, (2) development of the river for navigation, (3) the generation of electric power, (4) proper use of marginal lands, (5) reforestation, and (6) the economic and social well-being of the people. He concludes that only the government could have undertaken such a project in its entirety. Though the TVA was clothed with the power of government, it possessed the flexibility of private enterprise, and much that was originally managed by the Federal government is now handled by state and local authorities. Engraved on every generator are the words: "Built for the people of the United States."

BOREK, ERNEST. *Man, the Chemical Machine*. New York 27: Columbia University Press. 1952. 219 pp. \$3.00. In 1828 Friedrich Wohler jubilantly discovered that he had created urea synthetically. This achievement was the beginning of biochemistry, now a fundamental and indispensable branch of science. Wohler's discovery has been an "influence in shaping our lives," says the author, "far greater than the influence of atomic energy will be." With Friedrich Wohler's accomplishment, this book—the first integrated presentation of biochemistry for the lay reader—is launched. It traces the growth of knowledge about the chemical nature of living matter from Wohler's time to very recent research. It unfolds the biochemist's view on the mechanism of the living machine and shows how he changes his ideas with new findings. The ultimate chemical basis of genetics, of immunology, and of virus research is developed for the first time in any book.

BURLINGAME, ROGER. *General Billy Mitchell*. New York 26: McGraw-Hill Book Co. 1952. 222 pp. \$2.40. General Mitchell is still a controversial figure among his compatriots. The author of this book in writing the story of Mitchell's life tries to find a path between the extreme point of view held by his associates.

BUTLER, SAMUEL. *The Way of All Flesh*. New York 10: E. P. Dutton and Co. 1952. 504 pp. This is the one book by which Dr. Butler is generally known to the American public. The book contains an introduction "About Samuel Butler" and notes by George M. Acklom.

CAMPBELL, SAM. *Nature's Messages*. New York 11: Rand McNally and Co. 1952. 221 pp. \$3.50. Here is a book as refreshing to the spirit as a vacation in the north woods—a book that brings to the reader the peace of mind and spiritual uplift that only close communion with nature can give. It takes you into the peaceful depths of the great forests; shows you the beauty of dawns and sunsets over rippling lakes; points out the messages that nature has for every observant man or woman. Above all, it presents the comforting assurance that all is well with the world.

CASPARY, VERA. *Thelma*. Boston 6: Little, Brown and Co. 1952. 342 pp. \$3.50. Thelma Raissler was not born with a silver spoon in her mouth, and that may be why she was so infatuated with the "magic of worldly goods." She was determined that her daughter should have "everything." By "everything" Thelma meant "all the advantages" she herself had never had as the child of a widowed Polish working woman, growing up in a successful and self-satisfied American environment—money and social position and, of course, happiness—everything, "just like in the movies." The author's story of mothers and daughters can best be described as "a memoir in the form of a novel."

CHASE, A. E. *Famous Paintings: An Introduction to Art for Young People*. New York: Platt and Munk Co. 1951. 112 pp. \$3.50. The world may be a smaller place than it was, thanks to air transportation; but the Louvre and British Museum, the National Gallery in Washington, and the Rijksmuseum in Amsterdam are still a long way off for most of us. And too few youth up to now have discovered how many famous paintings and sculpture of the past five thousand years are even better than the newest comic book. But most youth will probably love instinctively and remember all their lives such pictures in color as "Children's Games" by Bruegel, "The Shrimp Girl" by Hogarth, "The Fifer" by Manet, and "The Dancer" by Degas. This book of 172 reproductions with 50 in full color, printed in Holland, tells youth in terms of their own experience what to look for in each painting and how the painter achieved his effect.

CHRISTENSEN, E. O. *Ceramics, Early American Designs*. New York: Pitman Publishing Corp. 1952. 48 pp., (8½" x 11"). \$1.75. This is a selection of ceramic decorations from collections of original, early American folk art, reproduced by courtesy of the National Gallery of Art in Washington, D. C. Some are simple motifs outlined in the clay, and at times filled in with color. In others, lines and dots are applied in slip; or leaf-and-floral

motifs are incised through the glass to reveal the red color of the earthenware. Over sixty illustrations are included with identifying captions to help the collector or designer interested in experimenting in this field.

CLUNE, H. W. *By His Own Hand*. New York 11: Macmillan Co. 1952. 586 pp. \$3.95. This novel is the story of the "heavy hand of power imposed by one man on an American city; it is a paradox of success and failure; it is a broad and detailed picture of a segment of the American scene." This is true Americana, from the year 1906 when broughams, Welsbach gas burners, and ball and drawing room customs from the mid-eighties still prevailed, through the mad 1920's and the post-depression years of the 1930's.

COCHRAN, R. E. *Be Prepared!* New York 16: William Sloane Associates. 1952. 248 pp. \$3.50. The author has spent twenty years as a Scoutmaster and says he'd welcome twenty more. This is a very warm first-person story. The author happened to like what he was doing, so he did it extremely well and tells about it accordingly. Here are anecdotes of almost every triumph and tragedy that can happen to a scoutmaster, the boys in his troop, and their entangling alliances. There are hysterically funny sections, quietly amusing sections, absorbing and dramatic sections. First and last, this is a man telling of the trials and rewards involved in a genuine labor of love . . . the guidance of growing boys from every walk of life.

COOMBS, CHARLES. *Young Readers Water Sports Stories*. New York 10: Lantern Press. 1952. 189 pp. \$2.50. In this book the author relates some fascinating tales of swimming, diving, boating, and all the other water sports, but at the same time, by the action of the stories, there is conveyed to the young reader the basic principles of water safety.

DAVENPORT, BASIL, editor. *Great Escapes*. New York 16: William Sloane Associates. 1952. 423 pp. \$5.00. All through history brave and stubborn men have been escaping from every sort of confinement and eluding their captors with such courage, ingenuity, and fortitude that their stories make fascinating reading. This volume contains the stories of true escapes of many kinds of people from many kinds of disaster, ranging from the days of Xenophon to the present.

DAVIDSON, L. B., and DOHERTY, EDDIE. *Captain Marooner*. New York 16: Thomas Y. Crowell Co. 1952. 384 pp. \$3.95. This is a sea yarn based upon one of the most violent mutinies in America's maritime history. When the narrator, a fifteen-year-old Quaker named George Comstock, boarded the whaling vessel *Globe* on December 15, 1822, he wrote in his diary prophetically, "Three years! God help me!" But it was well over three years before he returned to Nantucket to stay, a man now and a witness to murder, mutiny, and terror on the high seas.

With his older brother Sam as boat steerer, George Comstock first came to know the excitement, the danger, and the suspense involved in capturing a whale. But he also discovered the brutal, sadistic nature of Captain Worth, who loved whale oil more than he did men and who reveled in flogging his crew for insubordination. This tale of adventure and of wanton romance is steeped in absorbing suspense. It is the story of Captain Worth—hated and feared by his crew; of the Quaker Sam Comstock, a selfish handsome rogue who dreamed of an island empire peopled by exotic South Sea islanders; of George, constantly overshadowed by his more dashing brother; of Joe Thomas, mystery man and Jonah whose power for returning from the dead haunts his tormentors. Based on true happenings, this story is hard to match for drama on the high seas.

DAVIS, K. S. *Morning in Kansas*. Garden City, N. Y.: Doubleday and Co. 1952. 382 pp. \$3.95. This is a story of physical and moral rebirth, of triumph against great odds. It is the story of an ingrown adolescent haunted by indecision, terrified by abstract fears, and plagued by nameless complexes. A self-centered boy, forced into a pattern of loneliness by his unique talent for making people dislike him, he finds an odd fascination in the Baldridge place.

DONALD, DAVID, text editor; MILHOLLEN, H. D.; KAPLAN, MILTON; and STUART, HULEN, picture and caption editors. *Divided We Fought: A Pictorial History of the War 1861-1865*. New York 11: Macmillan Co. 1952. 464 pp. \$10.00. This is the story of the Civil War in five hundred illustrations selected from thousands of photographs and drawings made on the actual fields of battle—from Fort Sumter to Appomattox. The collections of Brady, Gardner, O'Sullivan, Cooley, and Cook; museums and private collections of the South; the albums of Forbes, Waud, and other artists have been sources of the material. The text is composed of chapter introductions and captions, the latter in most cases being based on original letters or eyewitness accounts pertaining to the pictorial content. The Civil War is considered the best photographed war in history—surpassing even World War I and II. Particular care has been taken to ensure adequate representation of the Southern side. Picture captions, in most cases, are based on original letters or eye-witness accounts which give life and meaning to the pictures. Here are accurate pictures of uniforms; here are colorful details of battle; here are the generals, the subordinate officers, the fields of battle, the camps, the gunboats, the batteries, the wounded, the dead, and the soldiers on both sides.

DORF, PHILIP. *The Builder: A Biography of Ezra Cornell*. New York 11: Macmillan Co. 1952. 459 pp. \$5.00. In this book, a biography of the founder of his alma mater, Mr. Dorf writes that Ezra Cornell "built for all time" and describes the ingenuity which Cornell displayed throughout his life (as carpenter and mechanic, as livestock breeder, as a founder of the Western Union Telegraph Company, as millionaire and philanthropist) as that of a "true Yankee who holds that if the right tool isn't available, there is only one thing to do—build it." "A broad river may have its sources in innumerable tiny streams, often in far-distant hills and forests; so may the well springs of a man's decisive actions originate in a multitude of seemingly trifling incidents of his earlier years." With this reflection, the author covers the increasingly effective actions of Cornell in regard to his own inventive and alert interests, his care for his family, for his home town, through ever-broadening activities which included an appointment to the first nation-wide Republican Convention meeting in 1856, election to the legislature of New York, 1861, the Civil War years, attendance at the International Exposition at London as an official delegate of the New York State Agricultural Society, his founding of a free public library, and, finally, the labor of founding "an institution where any person can find instruction in any subject." After he was fifty-eight years old, the author discovers, "the future of Cornell, the man, was secondary to the future of Cornell, the university."

EDMONDS, W. D. *Corporal Bess*. New York 16: Dodd, Mead and Co. 1952. 189 pp. \$2.75. This is the story of the close friendship between a boy and a dog. Pete tracked his father and Corporal Bess closely all the time she was being trained as a great hunter. And he went along to Syracuse with her for the dog show—which had a bang-up surprise ending!

EIDE, A. H. *Drums of Diomedé*. Hollywood 27, Calif.: House-Warden Publishers, 5228 Hollywood Blvd. 1952. 242 pp. This is the story of the transformation of the Alaska Eskimo dedicated to the teachers in the native service of Alaska. It is based on the historical background and the ancient customs, rites, and traditions of the Diomedé Island Eskimo, among whom the author had lived as a U. S. government agent and teacher.

EVERS, ALF. *The Colonel's Squad*. New York 11: Macmillan Co. 1952. 200 pp. \$2.75. This story began when the colonel "popped up" from a hole under the fence at the Alexandraya Orphanage. For Katya, Tanya, Sascha, Sergey and Natascha, five Russian refugee orphans, it was the beginning of an exciting story which went on to a happy ending in America. The colonel brought fun and food to the orphanage, and one day, after he had treated the children to pumpkin pies, he decided to take five of them home to America with him. Brought up by "army style," the children became familiar with such things as regulations, mess call, and inspection; and they went on maneuvers, with the sergeant, their

teacher. Their early experiences were a bit bewildering but soon they felt like a family; and, though the colonel continually found situations which stumped him, he discovered that a household of children could be very heartwarming.

FELSEN, H. G. *Cub Scout at Last!* New York 17: Charles Scribner's Sons. 1952. 131 pp. \$2.00. The story starts with Jerry's initiation into the Cub Scouts, and tells of the trials and successes of Den 4 as they prepare for the council exposition. There is fun and plenty of activity along the way.

FERBER, EDNA. *Giant*. Garden City, N. Y.: Doubleday and Co. 1952. 447 pp. \$3.95. Leslie had come from Virginia to Reata Ranch as the bride of its fabulously rich and powerful overlord, Bick Benedict. In the years that had passed since that day, Leslie had learned many things about Texas. At first she had been stunned by the hugeness of all she saw: the fifty-room house, surrounded by two and a half million acres of grazing land; skyscrapers rising from arid plains; endless herds of cattle; droves of Mexican workers; and a master race of enormous men who traveled in private railroad cars, later in tremendous and speedy automobiles, and now in private DC-6's. Slowly she came to understand. She learned that this seemingly boundless state cried out for big things to justify its very size; that its men lived, dreamed, built, and bought in terms of superlatives; but that, in their obsession with sheer magnitude, these giant Texans had somehow shrunk the human spirit.

FORD, ALICE, editor. *Audubon's Butterflies, Moths, and Other Studies*. New York 16: Studio-Crowell. 1952. 120 pp. \$5.75. The rediscovery of Audubon's remarkable, jewel-like original paintings of butterflies, moths, and other insects, as well as small reptiles, has provided the basis for the present work. Never before have these studies been reproduced. Handed down through four generations from Mrs. Charles Basham, to whom Audubon presented the album in 1824, the water colors the artist created in the bayou regions of New Orleans and Natchez are for the first time made accessible to the public through the courtesy of Mrs. Kirby Chambers, their present owner. Complementing these water colors are a selection of Audubon's immortal bird paintings of the same period and region (among them the much loved bluebird and hummingbird) presented in color. These reproductions introduce the reader to the true genius of Audubon, unknown to countless admirers without access to the rare originals.

FOSTER, HAL. *Prince Valiant Fights Attila the Hun*. New York 22: Hastings House. 1952. 128 pp. \$2.75. Readers who thrilled to the daring exploits of the youthful Prince Valiant in the author's first book will welcome this second volume of the deeds of the adventuresome Sir Valiant, Prince and Knight of King Arthur's Round Table. As a more mature and experienced leader of men, Val embarks with his father to reclaim their rightful throne in Thule and then wields his Singing Sword in aid of a Europe aflame with the ravages and plunderings of Attila's barbaric hordes. As Val is engulfed in the events of an imperiled civilization, the prophetic words of Sir Gawain, "You have much to do, Sir Valiant . . .," prove to be true. His heroic actions in the defense of Andelkrag, his leadership and strategy as his small band of free men harass and destroy the common foe, and his capture of maiden hearts who thrill to the feats of the handsome knight combine to produce a romance of fact and legend.

GAER, JOSEPH. *The Lore of the New Testament*. Boston 6: Little, Brown and Co. 1952. 383 pp. \$5.00. Through selections from the rich folklore of the literally thousands of legends which have grown up around the New Testament—chronologically arranged in a stirring progression of events—this book presents the life of Jesus, as reflected in folk imagination. Much of this material will come as a surprise to the layman, particularly the legends on the so-called unknown life of Jesus; for many of these legends and beliefs come from sources up to the present known principally to scholars and students of the New Testament lore and the strange new gospels that have appeared from time to time.

GERSON, N. E. *The Cumberland Rifles*. Garden City, N. Y.: Doubleday and Co. 1952. 314 pp. \$3.50. The soldiers of the redoubtable John Sevier were singing when Rosalind Walker, a pretty schoolteacher from Boston, arrived in the free state of Franklin—a territory which encompassed most of what is now Tennessee. Tall and slender, "with a ripeness of figure that had come with recent womanhood," she had a mass of soft golden curls falling to her shoulders. Rosalind had just been given a contract to open a girls' seminary in Franklin. While she was looking forward to her new life on the frontier with eagerness, she was weary from a more than normally harrowing journey through the unsettled wilderness. Only that day had she been miraculously delivered from an attack of bandits—saved by a handsome stranger with a foreign accent and a roving eye—Janus Elholm. In Nashville, Rosalind immediately sought the protection and companionship of Harold Jordan, another Bostonian, who had been in Franklin for many months. Unknown to Rosalind, both Harold and Janus were agents for the Spanish crown—Janus, commander in chief of Spanish forces in the New World, no less. They were part of a plot to overthrow the stripling governments of Franklin and Kentucky with the aid of the Choctaws and Cherokees, a plot that was only the first step in overrunning the entire struggling young republic.

GORSLINE, DOUGLAS. *What People Wore*. New York 17: The Viking Press. 1952. 280 pp. (9" x 12"). \$7.50. Here in one volume is a comprehensive survey of the history of dress in the Western World—a unique visual encyclopedia that includes, for the first time anywhere, a detailed section of Americana. This is a book for the lay reader or the professional—for anyone interested in or seeking data on fashions through the ages. Comprising nearly eighteen hundred line drawings—twelve pages in color and fifty pages of text, the book covers Western fashions from 2750 B.C. to 1925 A.D. The author, a noted illustrator, etcher, and painter, created the drawings from contemporaneous sources, instead of using the usual photographic reproductions, in order to achieve meticulous clarity free of irrelevant background material. The result is not only an invaluable reference book, but in itself is also a work of art—and a colorful pictorial social history as well.

Beginning with a brief review of the ancient world, the book then traces in greater detail European costume trends from the medieval period to World War I—including such specialized facets as armor and headgear. The last third of the book presents a survey on American dress from mid-nineteenth century—the period when it began acquiring specific national characteristics—to 1925. The frontier, for example, which produced a definite folk dress, is fully depicted, as are numerous types of work-clothes native to America alone. In illustrating this section, the author has made rich use of photographic archives, which, until he drew on them, had been virtually untapped.

The illustrations appear on chronologically dated pages, grouped according to periods, making possible instant reference-use. There is also an over-all list supplying the source for every drawing. A lively, prefatory text opens each section, and historical calendars of major events and personalities highlight the periods under review. Ease of identification is an important feature of the presentation, which is distinguished by simplicity, clarity, and a sense of devoted artistic enthusiasm.

HARBAGE, ALFRED. *Shakespeare and the Rival Traditions*. New York 11: Macmillan Co. 1952. 411 pp. The author presents a new synthesis of the facts about Elizabethan theatres and the content of Elizabethan plays as a means of defining Shakespeare's materials and intentions. The book is not a descriptive chronicle or a critical survey. In it, the author concentrates upon the single central problem: How did the Elizabethan theatrical industry organize itself in order to serve its clientele, what was the view of life which this clientele brought into the theatres, and how was this view of life reflected or refracted in the plays? What will seem to be the chief novelty of the book is its insistence upon the duality of Elizabethan drama. The author has preserved, throughout, the distinction between the drama of the public theatres, where Shakespeare was placed, and the drama of the private

theatres, where he was not. He presents the popular play and the coterie play and is hopeful that future discussions of Elizabethan drama will be influenced by the distinction made.

HARRINGTON, RICHARD. *The Face of the Arctic*. New York 21: Henry Schuman, Inc. 1952. 383 pp. \$6.00. The face of the Arctic is seen here at close range. This book is the record in words and photographs, by a distinguished cameraman, of the people and things he saw on five journeys to the Canadian far north. The author traveled more than 300 miles by dogteam, sharing the life of the Eskimo and living in caribou skin tents and igloos. In 1947 he lived with the Chipewyans of northern Manitoba; in 1948 he traveled along the greater portion of the eastern shores of Hudson Bay; in 1949 he accompanied a Royal Mounted Police constable on a patrol of the sparsely inhabited lands of the Coppermine Eskimo; in 1950 he visited the Padleimiuts in the land of the Little Sticks; in 1951 he made his journey farthest north, to Boothia Peninsula. The last three journeys are treated in greatest detail in this book, providing a picture of the Arctic in the season of winter darkness, and the miraculously beautiful season of eternal sunlight.

HAVIGHURST, WALTER. *George Rogers Clark*. New York 36: McGraw-Hill Book Co. 1952. 224 pp. \$2.40. This is one of the books in the series "They Made America"—a series of biographies. This book relates the incidences in the life of the great soldier of the West.

HOOVER, HERBERT. *Forty Key Questions About Our Foreign Policy*. Scarsdale, N. Y.: Updegraff Press. 1952. 106 pp. \$2.00. Of all the issues facing us as citizens and voters, none is quite so important today as our nation's foreign policy. Few of us have the background knowledge to form intelligent opinions. Yet mistakes in our foreign policy can lose us the friendship of long-time allies. Wrong decisions can work permanent injury to our economic system, and even wreck our American way of life. Ignorance or indifference on our part may result in our country's being drawn into a third world war too terrible to contemplate. No human being's judgment is infallible; and we live in a time of swift developments which can alter our situation almost overnight.

For the benefit of the earnest citizen who is looking for light on our foreign relations, the addresses and statements of Herbert Hoover have been analyzed against a list of 40 questions. Whether agreeing with all the answers or not, no citizen can spend an hour following down these forty questions without being able to form more intelligent judgments on the foreign policy decisions which are likely to face our country in the coming months.

HOWARD, J. K. *Strange Empire*. New York 16: William Morrow and Co. 1952. 615 pp. \$6.00. This book describes, for the first time in detail, the heroic struggle of a primitive people to establish their own empire in the heart of the North American continent. Throughout his lifetime, the author was absorbed by the fateful dream of these American primitives, the Metis: their fathers, the English, the French, the Scots frontiersmen; their mothers, the American Indians.

The homeland of the Metis encompassed the Great Plains country, west of the Red River astride the forty-ninth parallel, where the United States and Canada meet. But the Metis dream of autonomy, the natural desire of all peoples, clashed with larger ambitions, and it was their tragic destiny to fall before the forces of greater empires. These are facts presented in narrative form as exciting as fiction. Aside from the main drama are fascinating sidelights concerning such famous historical personages as John Paul Jones, Daniel Webster, the son of Charles Dickens. There is a new account of the Battle of Little Big Horn, and the story behind the United States' offer to buy the Northwest Territory in hopes of gaining a corridor to Alaska. It is the first book in English to give in detail the development of the great annual buffalo hunt.

HUGHES, LANGSTON. *The First Book of Negroes*. New York 21: Franklin Watts. 1952. 69 pp. \$1.75. As Terry, a little Negro boy, learns the vivid and absorbing story of his people in America and in the world, he gains hope and faith in democracy. This is a book with a message for all young Americans.

HUNGERFORD, E. B. *Forge for Heroes*. Chicago 5: Wilcox and Follett Co. 1952. 256 pp. \$2.50. This is a historical romance with an American background. The story takes place on land, at the cold, miserable camp at Valley Forge. Its hero is at first more impressed with the general miserableness of the place than with the greatness that is being forged there. The book gives an impressive picture of the hardships of those dark days, interspersed with some rollicking good fun; and the adventures, in which Mark Meriel proves what he's made of, are a fine combination of danger and impudent daring.

HUTTON, CLARKE. *A Picture History of France*. New York 21: Franklin Watts. 1952. 64 pp. \$3.00. This is a large picture book that recreates the life and culture of France through the ages. In it the pageant of French history is described in terms not only of kings and queens, wars and politics, but also in terms of musicians, writers, and craftsmen—the real people of this great nation. Full-color illustrations enrich each page. The aim of the book is to show what it was like to live in France throughout this crowded period of history and to portray, against the changing picture of town and countryside, the pleasures and fashions of each succeeding generation.

JACKSON, CAARY. *Shorty Carries the Ball*. Chicago 5: Wilcox and Follett Co. 1952. 150 pp. \$2.50. A new life opens for Danny Cleary and his friends when they enter the sophomore class at South High School. They are all trying to find their way in a new environment, and the biggest problem in each boy's mind is whether he'll make the football team. Danny has his eye on the quarterback position. He is determined to make the grade—even though the senior letterman who played quarterback the previous year is still on the team.

JAMES, B. R., and WATERSTREET, MARY, editors and compilers. *Adlai's Almanac, The Wit and Wisdom of Stevenson of Illinois*. New York 21: Henry Schuman, Inc. 1952. 80 pp. (paper cover). \$1.00. This book presents a sampling of Governor Stevenson's wit and wisdom as gleaned from his many speeches.

JOHNSON, ALVIN. *Pioneer's Progress*. New York 17: Viking Press. 1952. 423 pp. \$5.00. Alvin Johnson is perhaps best known as a founder of the New School for Social Research and its first director. The outstanding institution in America for adult education, the New School epitomizes Alvin Johnson's belief that the groves of academe belong next door to the public forum. Alvin Johnson's autobiography is a book about many things. It is about pioneer days in the Midwest, for he grew up on a remote Nebraska farm homesteaded by his Danish-American father, and subsequently went to the then-young University of Nebraska. Much later, after many years of studying and teaching, his career as a professor of economics in major American universities was paralleled by a constantly widening stream of public activities flowing from other interests.

JORDAN, G. R. *From Major Jordan's Diaries*. New York 17: Harcourt, Brace and Co. 1952. 284 pp. \$3.50. This story, never revealed in its entirety before, is told with full documentation by Major Jordan, who served as liaison officer with the Russians at Great Falls, Montana—the great staging base for Russian Lend-Lease supplies. Major Jordan's revelations are based on complete and detailed figures, obtained from the Russians and never before printed, which he calls "The Greatest Mail-Order Catalogue in History." These records which went through his office cover an incredible assortment of non-military supplies: cosmetics, musical instruments, amusement park equipment, a pipe for Uncle Joe—and atomic materials—\$9,500,000,000 of Lend-Lease to Russia.

JOSEY, C. C. *Psychology and Successful Living*. New York 17: Charles Scribner's Sons. 1952. 423 pp. \$3.00. Many young persons approaching adulthood are deeply disturbed by social and personal problems. In times of rapid social change, uncertainty, and confusion, the difficulty of becoming the man or woman one would like to be becomes greater. At such times, it becomes doubly important for a person to have a clear understanding of what constitutes successful living and of the difficulties he can expect in reaching the goals he has

set. Such understanding will not only help a person to evaluate his goals and to pursue them more intelligently, but it will also help him to maintain a tolerant attitude toward those who have not been as successful as he in developing a wholesome pattern of life.

A systematic study of human nature, of the fundamental needs of man, of individual differences, and of the sources of error in observation and memory should help everyone meet more successfully his problems, to take better advantage of his opportunities, and to be more understanding of and helpful to others. This book of 17 chapters attempts to give guidance to the individual in order that he may live successfully.

KENNAN, KENT. *The Technique of Orchestration*. New York 11: Prentice-Hall, Inc. 1952. 335 pp. This is a beginner's text which covers all practical aspects of scoring for small, medium, and large orchestras. It combines full treatment of individual instruments with full treatment of their use in sections and groups of sections; proceeds logically to equip pupils as quickly as possible for score reading; is oriented to American usage; gives the latest information on instruments; and reflects 20th-century developments in composition. Instruments are taken up individually at first, then by section; finally, sections are combined. The first fifteen chapters deal almost entirely with chordal and homophonic music; polyphonic music is treated in Chapter XVI. Pointers throughout the book on scoring for high-school orchestras are summarized in Chapter XVIII. The text goes into detail with specific directions for using instruments effectively (e.g., bowing, slurring and phrasing of strings, attacks and releases of woodwinds). Many different ways of scoring the same passage are given as well as numerous ways of handling a single sonority in fusing woodwind and/or brass instruments. A separate bound workbook furnishes appropriate and instructive music for assignment.

KEYES, F. P. *Steamboat Gothic*. New York 18: Julian Messner. 1952. 576 pp. \$3.75. In this book the author tells the story not only of the great Louisiana plantations, but also of the river which contributed so largely to their prosperity, their prestige, and their splendor. Plantations and the river, and the loves and lives of the men and women who peopled them are portrayed in this novel.

KILLILEA, MARIE. *Karen*. New York 11: Prentice-Hall, Inc. 1952. 314 pp. \$2.95. This book is a story of parental love. It is about an unusual child, slightly above average mentally, but handicapped in other ways. It is about family life, its friction and its fun, its common interest in baseball, its financial problems. It is about modern medicine, as a science and an art, and about individual doctors and nurses and therapists, and about the genesis and rapid growth of a great national organization, the United Cerebral Palsy Association.

KOHL, MARGUERITE, and YOUNG, FREDERICA. *The Holiday Book*. New York 17: David McKay Co. 1952. 224 pp. \$3.00. Written for the people who love the fun and festivities of holidays, this book answers problems of food, parties, table settings, decorations, and things to make and do for the main holidays of the year. Here, collected in one book, are hundreds of new and traditional ideas for celebrating with family and friends.

LAMB, HAROLD. *Theodora and the Emperor*. Garden City, N. Y.: Doubleday and Co. 1952. 336 pp. \$4.50. The story of the first notable man-and-wife team of modern history is told in this fascinating double biography. Theodora, daughter of a Syrian bear trainer at Constantinople's Hippodrome, started her professional career at the tender age of five as a child clown. Theodora was driven by a consuming ambition for self-improvement. Her cleverness soon won her the protection of men who found her entertaining to take on their travels. In her wanderings around the Near East this strange Syrian girl acquired a veneer of refinement and a deep respect for the church and its power.

At about the same time that Theodora was capering in the Hippodrome, young Peter Sabbatius, a Macedonian peasant, arrived in Constantinople to seek an education in the law. He was to live under the sponsorship of his old uncle Justin, a veteran of the Roman

Wars and a man highly regarded by the emperor, Anastasius. At the emperor's death, and after some fast political maneuvering by Peter (who had taken the name of Justinian by this time), the old soldier of fortune, Justin, was chosen emperor and Justinian became the brains—if not the power—behind the throne.

When Justinian had become virtual co-emperor with the aging Justin, Theodora returned to Constantinople under the guidance of a monk. Then she and Justinian met. Their eventual marriage, long thwarted by law and by the stupid jealousy of Justin's camp-follower queen, changed the whole course of the Roman Empire's waning power. Each supplied the qualities of sovereignty the other lacked. Justinian, who became emperor upon the death of his uncle, was a studious man of law—a planner, timid rather than heroic in the face of danger. Theodora, by now possessed of an eerie beauty and a tremendous personal magnetism, was the quiet but iron-willed queen who had her own court and who made it plain that deputations to Justinian must pay homage to her as well if they expected success.

LARIAR, LAWRENCE, editor. *Best Cartoons of the Year 1952*. New York 16: Crown Publishers. 1952. 128 pp. \$2.50. For over ten years, America's Cartoonist-in-chief, Lawrence Lariar, has edited the nation's annual laugh-provokers. This one is a bumper crop. The 300 cartoons have appeared in *Collier's*, *The Saturday Evening Post*, *Cosmopolitan*, *American Magazine*, *Argosy*, *This Week*, and many other national magazines and leading newspapers. The famous cartoonists have selected their own favorites—the highspots in the humor of a land that has the zest to laugh at itself.

LEACH, MARIA, editor. *Standard Dictionary of Folklore Mythology and Legend*. New York 10: Funk and Wagnalls Co. 1952. 1208 pp. \$10.00. Two volumes. Nowhere has the richness, vitality and range of world folklore, mythology, and legend been better exhibited than in this major, overall survey—compiled for the first time for the general reader as well as for the folklorist. In it the folk stories and songs—the gods, heroes, fairies and demons, angels and devils, ogres, guardian spirits, witches, vampires and zombies—of many different cultures—and in their many varying cultural forms—come to life in 4,000 entries, each a fascinating story in its own right.

Here in this new dictionary the folk heritage of the world unrolls, giving a glimpse of ancient Assyrian, Babylonian, and Egyptian religious beliefs; a broad view of a Hebrew folk hero; an insight into the nature of the supreme being worshipped by a tribe of North American Indians; a biography of a famous folklorist; the motif which underlies such stories as Romulus and Remus and Hansel and Gretel. Among the cultures which are given extended treatment in this first volume are Negro, American, Australian, Basque, Celtic, Indian, Cheremissian, Chinese, Estonian, European, Finnish, Finno-Ugric, French, Germanic, Indian and Persian, and Indonesian.

In it is found—in one alphabetical arrangement—a broad cross-section coverage of the folktales, fables, myths, legends, riddles, proverbs, rimes, tongue-twisters, jokes and insults, festivals, rituals and ceremonies, dances, games, and religious concepts of all the peoples of the world. Here is the folklore of animals, birds, plants, insects, stones, and stars, of foods and cures, magic charms and spells. The reader will get some insight into the vast body of Negro folklore—of which the well-known animal stories of Uncle Remus are only a small part of a remarkably large and diversified body.

The material in this dictionary is of two kinds: (1) original covering articles on specific cultures and types of folklore prepared especially for it by thirty of the world's foremost folklorists; and (2) brief informational write-ups presenting material heretofore scattered in rare and out-of-print books, in learned and obscure journals and memoirs, on records transcribed in the field by working anthropologists and collectors, in unpublished manuscripts, or passed on by word of mouth.

Volume I takes the reader through "I"; Volume II completes this alphabetical listing and adds four more authorities who did not appear in Volume I, and thirty-three additional ar-

ticles including: Jazz, Masks, Mnemonics, Oral Tradition in Music, Phallism, Primitive and Folk Art, Proverbs, Riddles, Types and Classification of Folklore. In this second volume is a broad coverage of such cultures as: Japanese, Latvian, Lithuanian, Melanesian and Micronesian; North, South, Mexican and Central American Indian; Polynesian, Pennsylvania Dutch, Semitic, Slavic, and Spanish.

LEYSON, B. W. *More Modern Wonders and How They Work*. New York 10: E. P. Dutton and Co. 1952. 192 pp. \$3.50. There are few mechanically minded men or boys who will not be completely fascinated to learn exactly what happens inside a gun when the trigger is pulled. Many boys own guns of their own, while many more dream of the day when they may. The first five chapters of this book are devoted to a careful explanation of the mechanics and construction of various types of guns. Other chapters are devoted to the history of locks and why and how they were unsatisfactory, with a full account of the greatest locksmith of all, Yale, and why this revolutionary lock became the standard all over the world; ultra high frequency, what it means, how it is being used today, and what its potentialities are; atomic powered submarines and how atomic energy is being utilized in construction, and in many other ways; phonograph records, how tape recorders are used, manufacturing under high fidelity conditions, plus a history of the development of Edison's invention of the great industry it is today.

LISSIM, SIMON. *How to be an Artist*. New York 36: Wilfred Funk. 1952. 224 pp. \$3.95. This book has been written to encourage the beginner or the amateur who wishes to express himself creatively. By exploring basic techniques, by discussing what everyone should know before attempting the arts, the author is urging the person to experiment creatively. With a sympathetic understanding of the problems, the author explores the rudiments of composition and design, the size of paintings, and the available portfolios of materials. Beyond this, the author tells what equipment and materials will be needed, how to organize the work, how to plan for indoor and outdoor sketching or painting—all the fundamentals of a stimulating and satisfying profession or avocation. The author tells where to turn for advice and what books should be read. Should the reader care to make money out of his "fun," she shows him how to qualify for the field of decoration, as a magazine or book illustrator, as an amusing or serious cartoonist, or the designing of greeting cards. The market in all these commercial fields is vast. And the hunger for fresh approaches and new material is great. If he wishes to go still further, he will learn how to organize exhibits, where to exhibit, and how to price his pictures.

MALONE, KEMP. *Chapters on Chaucer*. Baltimore: Johns Hopkins Press. 1952. 250 pp. \$3.50. This is a book to accompany the study of Chaucer, written by a scholar of medieval literature. After an introductory chapter which places Geoffrey Chaucer and the fourteenth century into the proper literary and historical setting, the author focuses his attention on the poems themselves, exploring the poet's method, analyzing his technique, and interpreting his stories in the light of the period in which he lived. The greater part of this work is devoted to a study of *Troilus and Criseyde* and to *The Canterbury Tales*, although the shorter poems come in for their share of critical attention.

MAYRANT, DRAYTON. *Courage Is not Given*. New York 1: Appleton-Century-Crofts. 1952. 278 pp. \$3.00. This story of Feuille Joany and her flight to the New World for her Huguenot beliefs is set against a varied canvas. It begins among the fruitful vineyards of eighteenth-century France, and the tall-sailed ships and teeming wharves of Bordeaux. Later, scenes take place in the London slums where refugees from France labored long hours at the looms of Silk Throsters' Lane. But the greater part of the story lies in the author's own beloved South Carolina, in the candle-lit drawing rooms of colonial Charleston and on the indigo plantations surrounding the settlement.

MILLER, M. S., and J. L. *Harper's Bible Dictionary*. New York 16: Harper and Bros. 1952. 880 pp. \$7.95. This is the first completely new Bible dictionary in thirty years. It is

thoroughly up-to-date in archaeology, geography, chronology, and other fields of contemporary Biblical investigation. Greater use is made of tables, charts, diagrams, and outlines than in earlier Bible dictionaries. The photographs and line drawings comprise what is probably the finest collection of Biblical illustrations ever put between the covers of one book. The famous Westminster historical maps of Bible lands make a most valuable appendix. No effort has been spared to make this book completely authoritative, useful, and readable. It should delight millions of Americans who want a one-volume reference as an ever-present aid to understanding the Bible."

MILNE, A. A. *Year In, Year Out*. New York 10: E. P. Dutton and Co. 1952. 215 pp. \$3.50. The author has here gathered together a varied collection of subjects ranging from the family life of bath sponges to the truth about Candida; from the naming of race horses to the relative intelligence of boobies, ostriches, and rooks; and from the absurdities of the Baconians to the philosophy of Karl Pearson, the atom bomb, and the art of saying thank you.

MIRSKY, JEANNETTE, and NEVISN, ALLAN. *The World of Eli Whitney*. New York 11: Macmillan Co. 1952. 364 pp. \$5.75. The fame of Eli Whitney as the man who invented the cotton gin is secure, but Whitney's importance extends far beyond that famous contrivance of 1793. He was a man of ideas, an important contributor to the Industrial Revolution in America and the father of mass production. It was Whitney who developed standard interchangeable parts for the musket, not only inventing the specific tools, but also pioneering in manufacturing processes and in using unskilled labor. Whitney's career was brief, but his pioneer activity in tools, machines, and methods has had a mighty sequel in Colt, Singer, McCormick, and Henry Ford.

This is the story of a Yankee schoolmaster, just out of Yale, demonstrating his gin model to the southern planters; a sober-minded businessman contracting with the government to produce muskets—strange description of a "revolutionary"! Considered in the light of the primitive technology of his day, Whitney's achievements were indeed revolutionary, and his persistence in the face of bitter opposition was a dramatic battle. The basis of this biography is the hitherto unpublished collection of family papers. Wherever possible, Whitney's personal story—his dealings with Stiles, Jefferson, and Fulton, his relationship with the fascinating widow of Nathaniel Greene, his marriage to a granddaughter of Jonathan Edwards—is told in his own words.

MOOS, MALCOLM. *Politics, Presidents, and Coattails*. Baltimore: Johns Hopkins Press. 1952. 259 pp. \$4.50. This book is a study of congressional elections and the battle fronts upon which the critical constituencies turn. Drawing attention to the growing disparity in the vote between major party presidential candidates and their respective congressional tickets—from an average difference of 5.3 per cent between McKinley's election and 1916, to 11.9 per cent for the period of 1916-1948—the author begins his analysis by examining the reasons for this defection in congressional voting.

Compacting the congressional election returns for the past fourteen years, the author breaks down congressional constituencies into three groups—the strictly one-party districts, the predominantly one-party districts, and the marginal districts—and sifts out the dominant voting characteristics for each group. Of the 106 districts designated as marginal, sixty are usually Republican and forty-six Democratic. Among this group, however, are forty-two that are critical, oscillating between the two parties by a vote that ranges from 48.5 to 51.5 per cent. These the author has singled out for particular attention. Descriptions of all marginal districts are accompanied by regional and sectional analyses of political trends, and the location of each of these constituencies is outlined on a state map.

Turning to the major focus of his inquiry, the author takes up the question of the president's coattail influence in national elections and demonstrates the conditions under which it is operable. In his analysis, supplemented by a series of graphs, the author depicts the

political behavior of congressional districts in midterm and presidential election years, indicating the parallelism in congressional-presidential voting and also the frequently neglected fact that coattail riding often involves a reversal of mount and rider. Of particular importance and usefulness is the appendix which, in addition to giving the percentage of the two-party vote received by every major party congressional candidate in each election since 1938, shows the relative strength of congressional and presidential nominees in national elections. The concluding chapter relates congressional election behavior to problems of political leadership, peeling off some of the fictions that have surrounded the coattail theory. It ends with some penetrating insights on the role of congressional elections in our party system.

MORENUS, RICHARD. *Crazy White Man*. Chicago: Rand McNally and Co. 1952. 320 pp. \$3.75. This is the story of one man who did what most of us have only dreamed of doing. Turning his back on New York, the author really got away from it all. He plunged into the Canadian wilderness to live for six long years on an island in a remote lake where winter temperatures sometimes plunged to 63 degrees below zero and the nearest trading post was many miles away. Why any man would voluntarily leave the fabulous white man's world to endure the hardships of wild Canadian bush country was a mystery to the Indians, his only near neighbors. Sha-ga-na-she wa-du-kee or "Crazy-White-Man" they called him and left him strictly alone until, surviving his first winter, he proved that he had the makings of a real bushman. A tenderfoot, the author had practically everything to learn the hard way. He tells of his struggles, sometimes grim and sometimes wryly funny, to learn the art of wilderness living; of adventures in blizzards; of experiences with primitive Indians and half-savage sled dogs.

NORDHOFF, CHARLES, and HALL, J. N. *Mutiny on the Bounty*. New York 21: Henry Schuman. 1952. 342 pp. This book is the true account of one of the strangest and most dramatic voyages ever made to the South Sea. Captain Bligh of the *Bounty* made life so wretched for his officers and sailors that mutiny developed on the high seas with only five minutes' planning. The original narrative has been faithfully kept in adapting the text, and only long and tedious descriptions and explanations have been eliminated or condensed. Three changes have made the book more enjoyable for the reader. First, the story has been made shorter; second, the number of chapters has been reduced from forty-five to twenty-four; and third, the vocabulary has been simplified wherever possible to keep within the first 7,000 words of Thorndike's *Teacher's Word Book*. In addition, maps and teaching aids have been included.

NORTHROP, F. S. C. *The Taming of the Nations*. New York 11: Macmillan Co. 1952. 376 pp. \$5.00. The author analyzes the foreign problems and policies of the nations of both the East and the West, including those of the United States. He looks closely into communist mentality and practice. He concludes with a positive foreign policy for defending the free world and controlling aggression through the United Nations.

PARADIS, MARJORIE. *One-Act Plays for All-Girl Casts*. Boston 16: Plays, Inc. 1952. 193 pp. \$2.50. The twelve comedies in this book were brought together to offer in one volume a selection of royalty-free plays suitable for all-girl casts. Written by a well-known author of stories for young people, these half-hour dramas portray typical teen-age girls in amusing situations: the complications which result when a mud-pack facial is interrupted by a school fire; the excitement when a bridesmaid gets her hand caught in a valuable gift vase a few minutes before the ceremony; and the tensions created when a small sorority has to account for its snobbishness to the famous actress who was once rejected for membership.

PATTERSON, ROBERT; MEBEL, MILDRED; and HILL, LAWRENCE. *On Our Way*. New York 11: Holiday House. 1952. 382 pp. \$3.50. A boy of 17 leaves his father's farm and does some major-league pitching that jolts the sports world. An actress still in her teens makes her debut by literally bringing the house down. A cub pilot on a riverboat shows

a brutish regular pilot where to get off. A boy sits behind a soldier on a horse during a bloody battle. A cowpuncher of 14 tackles his first man-sized job. A girl nurse training in a big-city hospital proves she can take it. After a fight a boy lies awake feeling the guilt of murder. Another spends a night in a deserted old ship to determine whether it is haunted. And twenty other stirring experiences of youth are told by the people who went through them, selected from some of the most unusual autobiographies ever written in this country.

PHOTOGRAPHY MAGAZINE, editorial staff. *Photography Annual*. New York 16: Crown Publishers. 1952. 236 pp. \$3.00. This annual, which sells half a million copies a year, is now available for the first time in permanent library-cloth binding. The 1953 edition is really two volumes in one. The first part is devoted to exciting pictures illustrative of the basic tools available and is in itself a comprehensive guide and source of inspiration to photographers, both amateur and professional. At the same time, the book offers a feast to lovers of fine photography. The second part is a presentation of the world's outstanding photography in both color and black-and-white including an impressive portfolio of the year's top prize-winning news pictures.

RUBIN, H. H. *Glands, Sex and Personality*. New York 36: Wilfred Funk. 1952. 217 pp. \$2.95. Our endocrine glands are the driving power behind our lives. Because of them we are thin or fat, ambitious or easy-going, full of pep or tired to death. They let us lead a normal, happy, healthy sex life, or they make us hide from the world as unhappy abnormalities. For many years doctors suspected that endocrine glands were a determining influence on our mental and physical well-being. Today there is positive proof that our glands are the link between the body and the mind. The author, in this book, summarizes and brings the latest, up-to-the-minute data about these glands, how they influence life and health, and suggests what may be accomplished medically to help keep them functioning as they should.

SAUNDERS, J. R., chairman. *The World of Natural History*. New York 10: Sheridan House. 1952. 321 pp. \$5.00. The American Museum of Natural History in New York is the most fabulous museum of its kind in the world. Its inside story is told here for the first time. The treasures of its many natural history collections, the dramatic expeditions that have unearthed new scientific knowledge, the curious happenings that are constantly occurring in the search for knowledge of nature are told by the author who has been on the staff of the Museum for many years.

SIEVERS, HARRY. *Benjamin Harrison*. Chicago 4: Henry Regnery Co. 1952. 366 pp. \$5.00. Benjamin Harrison, one of the great American presidents, emerges at last in this first full biography, as a lively, colorful and, at times, heroic personality. The author traces Harrison's life from his early boyhood in Ohio through the beginnings of his political career to his experiences as a Union general in the Civil War.

Although descended from a long line of Virginia burgesses and himself the grandson of President William Henry Harrison, Benjamin Harrison settled as a young lawyer in Indianapolis, with only a small income, a pretty wife, and a capacity for hard work. Shortly after the start of the Civil War, Harrison gave up his law practice and became a volunteer rifleman. His courage and boldness during the Atlanta campaign attracted the attention of Fighting Joe Hooker who exclaimed, "Harrison, by God, I'll make you a Brigadier for this fight!" At the close of the war, Harrison returned to civilian life a more understanding man and a more mature public servant. Here, in Benjamin Harrison's formative years, the author finds the solid foundations of the general's future life as Senator and President.

SIMMONS, CHARLES. *Plots That Sell to Top-Pay Magazines*. New York 36: Wilfred Funk. 1952. 216 pp. \$2.95. Here is a scientific approach to the problems of writing big-money fiction. This book is not one man's opinion of what magazines might buy! It is a factual report of what they do buy. Here, analyzed are the thirty basic fiction plots acceptable to the leading national magazines, outlined in detail, with simple but precise explanations of how to handle each.

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SIMON, C. M. *The Long Hunt*. New York 10: E. P. Dutton and Co. 1952. 152 pp. \$2.50. Jim's father had promised that when his height reached a certain mark on the cabin wall he would be ready for the "long hunt." But now the father was somewhere far away with the troops of Andrew Jackson, fighting the British. Or was he? Where was he? So Jim said good-by to his mother, to Granny and little sister Nancy, and with his sturdy horse and spaniel set out on a "long hunt" of his own. Through the wilderness, sometimes lost, now among Indians who might not be friendly, Jim pressed on. Then came a sunny morning in New Orleans when the search was over and the happy homeward trek began. Jim had proved his stature in more ways than one.

SPEER, C. A. *Sonnets for Eve and Other Poems*. New York 1: William-Frederick Press. 1952. 46 pp. \$2.00. Here is a collection of poems—poems about the most important woman of all: Mother Eve. The author of these little poems shows that she is very much aware of the wisdom (and folly!) of her own sex; she writes with tolerance and unusual understanding of the problems and triumphs of all women, from Eve on down through the ages to the present.

SPER, FELIX, editor. *Modern Short Plays*. New York 10: Globe Book Co. 1952. 262 pp. \$2.00. The one-act plays here presented derive from outside countries like Hungary, Spain, and Great Britain as well as from the United States. Though settings may differ, themes are rooted in common experiences of young and old. One excerpt from a long play of the kind known as episodic has been included because it satisfies the demands of unity and separateness. Finally this collection aims to capture a medley of moods both tender and tough, comic and pathetic.

STEVENSON, C. T. *First the Blade*. New York 10: E. P. Dutton and Co. 1952. 62 pp. \$2.75. This book marks the initial appearance of the author's poems collected for publication as a book. The first section of this book concerns a region dearly loved by the author, and is entitled "Vermont." The second is "Sunlight Through Vines," expressing a play of memory and emotion through the personal poems and period pieces which comprise it. The third is "Largo," a grave title for a grave group of poems of war.

STUART, JESSE. *Kentucky Is My Land*. New York 10: E. P. Dutton and Co. 1952. 95 pp. \$2.75. This book is the author's fervent reaffirmation of his passionate love for the Kentucky land in which he grew up, with its flowers and trees and weathers, and its infinite seasonal variety. The author returns to many of the scenes of his boyhood of which he wrote so eloquently in *Man With the Bull-Tongued Plow*, now writing of them with overtones of his later life and more mature point of view. While much of the work included in this book is frankly autobiographical, a great deal of it is objective. The eighty-four poems are divided into eight groups: "Kentucky Is My Land;" "The Ballad of Lonesome Waters;" "Songs for Naomi;" "Poems For My Daughter;" "Songs of a Mountain Plowman," in which he returns to the sonnet form he used with such unusual power and mastery in *Man with the Bull-Tongued Plow*; "Great Lakes Naval Training Station;" and "The Builder and the Dream." Here are the strong and beautiful ballads and sonnets the author's readers have come to expect from him, plus the use of some freer forms which are newer to the author but of which he is no less a master.

SWIFT, JONATHAN. *Gulliver's Travels*. New York 10: E. P. Dutton and Co. 1952. 224 pp. \$1.75. Arthur Rackham's beautiful illustrations for the famous eighteenth-century classic are among this great artist's best work. There is certain to be a wide welcome for this new edition in the Dent's Children's Illustrated Classics series.

SYKES, EGERTON, compiler. *Dictionary of Non-Classical Mythology*. New York 10: E. P. Dutton and Co. 1952. 280 pp. \$3.75. The author has included in this volume the important mythological names and places, with the exception of the classical world and the Arabian Nights myths. In alphabetical order appear the Nordic, Egyptian, Coptic, Ancient

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TEBBEL, JOHN. *The Life and Good Times of William Randolph Hearst*. New York 10: E. P. Dutton and Co. 1952. 386 pp. \$4.00. Here is the virtually unbelievable story of William Randolph Hearst's fabulous life, told for the first time by a biographer of America's rich men, who had access to hitherto untapped sources in revealing at last the why and how of the man whom many consider the most astonishing personality of our era.

TIDWELL, M. F.; PELZ, ELIZABETH; and WELLS, CAROL. *Legal Typing*. New York 11: Prentice-Hall. 1952. 240 pp. These authors duplicate the pace and atmosphere of an actual office for students just preparing for the legal stenographic profession and secretaries wanting a working manual on the most frequently used legal forms and papers. At the same time, this text shows a realistic, practical attitude toward the problems of the busy teacher. The book provides a complete, working set of laboratory materials, offers material based on actual cases and papers, and presents a smooth and teachable organization.

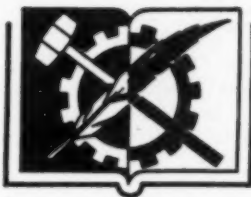
VOGEL, O. H. *Ins and Outs of Baseball*. St. Louis: C. V. Mosby Co. 1952. 453 pp. The fundamentals are discussed for the beginner; more advanced play for the player of experience. Coaching procedure and practice methods described are not meant to be rigid and set, since individual players will differ in their abilities. In a given situation several interpretations may be correct. The techniques discussed are those gathered over a period of years of experience and study in coaching and playing.

Each position is a complete unit of activity which in turn is co-ordinated with team play as a whole. Since a beginner is often primarily interested in only his position, he may overlook its relationship to another position. It was, therefore, deemed advisable to repeat a few certain plays in which several players are involved. For example, pick-offs, in which the pitcher, shortstop, and second baseman take part, are discussed within the chapters the Pitcher and Pitching, the Play of the Shortstop, and the Keystone Combination. The book contains 167 illustrations.

WARD, CHRISTOPHER. *The War of the Revolution*. New York 11: Macmillan Co. 1952. Two volumes, 1012 pp. \$15.00. The origins of this book are to be found in part in the late author's studies of the history of the Delaware Line. His volume on *The Delaware Continentals, 1776-1783*, published in 1941, contains much more than the story of one of the best units in the Continental Army. Approximately one half of the author's last work is to be found in his earlier monograph, which was put forth in a limited edition. This material, which deals with land operations in the middle and southern states after 1776, was revised by the author. To it he has added about forty new chapters on the campaign of 1775; operations in New England, northern New York, and Canada; border conflicts; and the Yorktown campaign.

The author intended to write a history of the campaigns on land rather than a complete history of the war. He largely accomplished his purpose, although his manuscript, as submitted to the editor, contained no account of the war beyond the Allegenies. The editor has supplied a brief description of that portion of the conflict in one chapter, emphasizing the role of George Rogers Clark. This book, with the exception of the chapter mentioned in the preceding paragraph, has been little altered by the editor. Additions to the citations and bibliography have been inserted in order to present a few of the more important scholarly contributions concerning the War of Independence not available to the author.

WARLOCK, PETER. *Delius*. New York 11: Oxford University Press. 1952. 224 pp. \$3.00. Delius was sixty years old when the author, under his real name, Philip Heseltine, wrote this well-known life. To Hubert Foss was given the task of writing a new introduction



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together with an additional chapter covering the last years of Delius' life. This new material, which includes a summary of critical commentary and a number of unpublished letters, will be of particular interest. Some personal reminiscences by Percy Grainger and a comprehensive list of Delius' published and unpublished music works with the date of first performance and a bibliography are also included in this entirely new edition.

WAUGH, EVELYN. *Men at Arms*. Boston 6: Little, Brown and Co. 1952. 342 pp. \$3.50. This is a novel of military life. It is concerned with the first year of the war. Guy Crouchback (who has nothing in common with the author beyond their common faith and age) is a romantic, spiritually crippled and socially isolated, numbed, and desiccated by previous misfortune. He sees in war the hope of personal revitalization. That is the theme of this novel. The plot is chiefly concerned with two highly peculiar officers, his brigadier and a junior officer of his own batch. The story ends with Guy Crouchback's first serious tiff with his beloved regiment.

WEEKLEY, ERNEST. *Concise Etymological Dictionary of Modern English*. New York 10: E. P. Dutton and Co. 1952. 496 pp. \$6.75. With the inclusion of a large number of new words, this revision of the book brings it up to date. In preparing this revised edition, the editor has aimed especially at simplification; all Greek words have been transliterated. Definitions are given only for unusual words and for the philological terms employed. With the natural advances made by science many new scientific terms have come into use since the publication of the original edition. Although only the more familiar of these countless new terms are included, the elements from which the remainder are composed will, in most cases, be found.

WHEELER, OPAL. *Stars Over Bethlehem*. New York 10: E. P. Dutton and Co. 1952. 60 pp. \$2.00. Arriving in Palestine from Egypt in a "tiny bucket plane" with a capacity load of four passengers, the author felt it was a dream come true. The excitement of busy Jerusalem, the mounting tension as she drew nearer and nearer to her goal, Bethlehem itself on Christmas Eve amid the Biblical scenes which in so many ways have never changed, the thrilling experience of the midnight service in the Church of St. Catherine are all told here by a writer whose imagination was fired and whose soul was stirred by the greatness and the perpetual mystery of the ceremonies of which she had at last become a part.

WILCOX, F. M. *Living On*. New York 1: William-Frederick Press. 1952. 52 pp. \$2.50. The author employs the concept of rebirth as a vehicle for portraying the changeless elements of human nature throughout an apparently changing world. With a background as broad and as pulsating as history itself, this work opens in the milieu of a primitive, prehistoric tribe, moves to the Egypt of the Pharaohs, and to our realistic twentieth century civilization.

WILLIAMS, W. C. *The Build-Up*. New York 22: Random House. 1952. 335 pp. \$3.50. This is a success story. Its account of the triumph of an immigrant American family during the early part of the century follows a traditional pattern—with one exception. The initiative, drive, and overwhelming ambition to carve a place of dignity and importance for the family stem from the female side, from Gurlie who married Joe Stecher, raised his children and guided his progress. Not that Joe, born in East Prussia, lacked the desire for success, but he often inclined to temporize, to dwell on ideas when forthright action was needed. Then Gurlie's timely reminders forced him, in a sense, to take the realistic view. As a result, he was soon "in the money." With Joe's financial position assured, Gurlie next set her sights on the summit of local society. Her energy was phenomenal, her success complete. Life was bountiful in every way.

WREN, D. K., and ROSEMARY. *Pottery Making*. New York 36: Pitman Publishing Corp. 1952. 152 pp. \$3.50. The ancient art of pottery making is covered in this new volume along with a full description of the building and firing of small kilns. The new methods



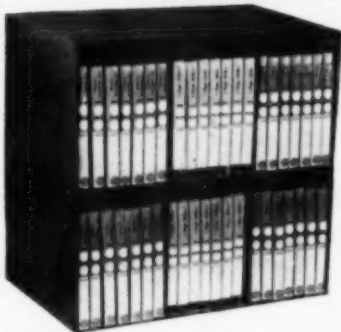
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YOUNG, I. S. *A Hit and a Miss*. Chicago 5: Wilcox and Follett Co. 1952. 240 pp. \$2.50. This book is a novel for older youth readers. One feels the inevitable conflict between the two boys, Corky and Talbert, so different in character and temperament, yet both so attractive, coming closer and closer until the catastrophe is almost a relief. They both suffer from the vanity of the same silly girl, a finely drawn example of a rather common type; and she certainly learns her lesson. This sports story presents a more complete picture of a high-school student's life than most, giving not only rousing baseball games but the excitement of a school play and some picture of a social life, both boy to boy and boy to girl. There are hints of ambitions and intelligent outside interests, and there are teacher-pupil relationships in which the teachers as well as the pupils are solid and well-drawn characters.

Pamphlets for Pupil-Teacher Use

APPLEBAUM, S. B. *Working Wives and Mothers*. New York 16: Public Affairs Committee. 1952. 32 pp. 25c. Discussion of this topic and suggestions to help those so engaged.

Approved Schools of Practical Nursing. New York 21: National Association for Practical Nurse Education. 1952. (July) 12 pp. Free. A list of schools accredited by the association and/or state accrediting authority.

ARMSTRONG, W. E., et al., editors. *Proposed Minimum Standards for State Approval of Teacher Preparing Institutions*. Washington 25, D. C.: Supt. of Documents. 1952. 32 pp. 20c. A set of standards as developed by a committee of the National Association of State Directors of Teacher Education and Certification to serve as a guide to states in further refining their own standards and procedures.

Australia in Facts and Figures. New York: Australian News and Information Bureau. 1952. 68 pp. Free. An official account of Australian policy, economy, and administration for the June quarter, 1951.

Aviation Books and Equipment. Los Angeles 26: Aero Publishers, 2162 Sunset Blvd. 1952. 32 pp. Free. A list of all books of publishers and the Government Printing Office, including prices and short annotations.

BADGER, H. G., and FARR, MAUDE. *Statistics of Higher Education: Receipts, Expenditures, and Property*. Washington 25, D. C.: Supt. of Documents. 1952. 67 pp. 20c. Chapter 4 of the *Biennial Survey of Education in the United States—1948-50*.

BARD, HARRY. *Teachers and the Community*. New York 16: National Conference of Christians and Jews, 381 Fourth Ave. 1952. 56 pp. 25c. Tells the story of what one important American city has done through in-service education to help its teachers arrive at new understandings of group life and relationships in the local community. The author is curriculum director in the Baltimore public schools.

BIRKMAIER, E. M., editor. *Illustrative Learning Experiences*. Minneapolis: University of Minnesota Press. 1952. 116 pp. Describes the action program of the University High School classes. Nine units of instruction described and outlined.

BLAKESLEE, A. L. *How to Live with Heart Trouble*. New York 16: Public Affairs Committee. 1952. 32 pp. 25c. Prepared to help the 10,000,000 people in the United States who have diseases of the heart or blood vessels—for the patient and his family.

The Blue Book of 16mm Films. Chicago: Educational Screen, 64 E. Lake St. 1952. 172 pp. \$1.50. This 27th annual edition contains annotations of over 7,300 listings of 16mm films classified under 182 subject headings. More than 1,000 new titles are listed for the first time.

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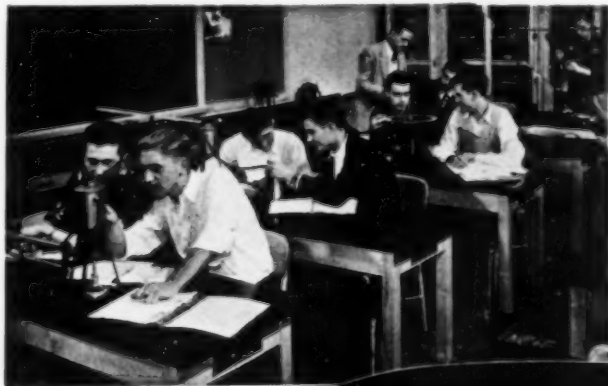


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Central Bucks Joint High School. Doylestown, Pa.: J. Edward Smith, Supt. 1952. 20 pp. A pictorial text presentation of this area secondary-school program in their almost \$3,000,000 building of 180,000 square feet of floor area on a 44-acre plot.

CHALMERS, G. K. *School and College Study of Admission with Advanced Standing*. Philadelphia 4: School and College Study of Admission with Advanced standing, 220 Wilford Bldg., 33rd and Arch Sts. 1952. 17pp. Describes the origin, purposes, and plans of this group as presented by the president of Kenyon College, President of the Central Committee.

CHRIST, H. I., and TRESSLER, J. C. *Practice in English Usage*. Boston 16: D. C. Heath and Co. 1952. 192 pp. \$1.00. Each chapter deals with a class of errors that pupils frequently make, omitting trivia and sticking closely to essentials. The diagnostic tests show where faulty habits exist. Explanations of correct forms tell of their functions in making the meaning clear. There is a great amount of variety of drill material—enough to establish good habits—to make the correct forms look right and sound right. Cumulative drills at intervals review and integrate skills. Lastly, a supplement containing final mastery tests with their answers is included with each book.

COMMITTEE ON EVALUATION. *Program Evaluation in Adult Education*. Washington 6, D. C.: Adult Education Association, NEA. 1952. 32 pp. 50c. Sets forth some of the major concepts and principles of program evaluation in adult education.

COMPTON, WILSON. *Paving a Road to Peace*. Publication 4757. Washington 25, D. C.: Dept. of State. 1952. 11 pp. An address before the American Legion Executive Committee in Indianapolis, Indiana, October 11, 1952.

COSGROVE, M. C., and JOSEY, M. I. *About You*. Chicago 10: Science Research Associates. 1952. 80 pp. (8½" x 11"). A book for pupil use giving information and activities to help them understand themselves and others better, and thus build a happier life. Volume I of the *Family Living* series.

DEUTSCH, ALBERT. *What We Can Do About the Drug Menace*. New York 16: Public Affairs Committee. 1952. 32 pp. 25c. Estimates nearly 60,000 addicts of whom about one-sixth are teenagers. Suggestions as to what can be done.

DIX, M. Q. *Soap Carving in the Classroom*. New York 10: National Soap Sculpture Committee, 160 Fifth Ave. 1952. 32 pp. Free. Aids to teachers interested in teaching this art. Also available is another 3-page article by the same author who is supervisor of art education in Elizabeth, New Jersey, entitled "Sculpturing is Fun."

DREIKURS, RUDOLF. *Character Education and Spiritual Values in an Atomic Age*. Boston 8: The Beacon Press. 1952. 24 pp. 50c. An address.

DU PONT, H. B. *Technology—Hope or Hobgoblin?* Wilmington, Del.: E. I. du Pont de Nemours and Co. 1952. 12 pp. Free. An address before the Association of Land Grant Colleges and Universities in Washington, D. C., November 11, 1952.

DURAND, F. C. *Creative Dramatics for Children*. Yellow Springs, O.: Antioch Press. 1952. 181 pp. \$1.50, paper bound; \$2.75, cloth bound. A manual for teacher and leaders giving suggestions as to how creative dramatics may become a part of classroom activities.

JURNHAM, FRANKLIN, and LOWDERMILK, R. R. *Television in our Schools*. Bulletin No. 16. Washington 25, D. C.: Supt. of Documents. 1952. 40 pp. 15c. Aids to those who are beginning to use television as a teaching aid both within and outside their classroom.

The Effects of Mobilization and the Defense Effort on the Public Schools. Volume 30, No. 3. Washington 6, D. C.: Research Division of the NEA. 1952. (Oct.) 40 pp. 50c. Presents the status of city school systems of the nation after the Korean conflict had been under way for nearly two years.

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SSERT, R. P., and HOWARD, R. W. *Educational Planning by Neighborhoods in Centralized Districts*. New York: Teachers College, Columbia University, Bureau of Publications. 1952. 144 pp. A report of the origin, evolution, and possibilities of an experiment of people of New York state in creating a new form of rural government through public education.

Evaluating Progress and Charting the Future of Teacher Education. Companion volume. Washington 6, D. C.: National Commission on Teacher Education and Professional Standards of the NEA. 1952. 46 pp. Transcribed reports of discussions presented at a series of seminars at the Kalamazoo Conference, June 25-28, 1952.

FREEMAN, LUCY. *It's Your Hospital and Your Life!* New York 16: Public Affairs Committee. 1952. 32 pp. 25c. Describes the complexity of hospital operation, the diversity of its activities, the spiritual motivation of its interests, and the progressiveness of its continuing development.

FREEMAN, W. S., editor. *The 1953 Annotated List of Phonograph Records*. Brooklyn 13: Children's Reading Service, 1078 St. John's Pl. 1952. 48 pp. 10c. This new edition, containing 1,000 selected recordings (33, 45, 78 rpm) suitable for kindergarten to high school, is designed to aid teachers in the selection of recordings for classroom use.

GLENNON, V. J., and HUNNICUTT, C. W. *What Does Research Say about Arithmetic?* Washington 6, D. C.: Association for Supervision and Curriculum Development of the NEA. 1952. 50 pp. 50c. Includes not only co-operative research carried on by elementary teachers in the classroom but also the large number of studies provided by specialists. Part I deals with "Arithmetic and the General Elements of School Curriculum"; Part II, with "Answering Specific Questions Regarding the Teaching of Arithmetic."

GRAMBS, J. D. *Group Processes in Intergroup Education*. New York 16: National Conference of Christians and Jews, 381 Fourth Ave. 1952. 84 pp. 25c. Summarizes the major available facts about group process and sets forth a number of group work methods that will be useful in the classroom.

Guide to Films in Economic Education. Washington 6, D. C.: Dept. of Audio-Visual Education of the NEA. 1952. 62 pp. \$1.00. Contains brief descriptions and appraisals of current films and filmstrips useful in economic education.

Guide to the United States and the United Nations. Publication 4653. Washington 25, D. C.: Division of Public Liaison, Dept. of State. 1952. 21 pp. Free. Our part in the U. N.

Handbook of Emergency Defense Activities. Washington 25, D. C.: Supt. of Documents. 1952. 126 pp. 30c. Issued semi-annually, this is an invaluable aid for the businessman or anyone having official relations with the government regarding defense activities. It contains names, addresses, and telephone numbers of principal officials and brief functional statements of Federal agencies whose functions are devoted primarily to the national defense program, such as the Office of Defense Mobilization, Defense Production Administration, Office of Price Stabilization, Mutual Security Agency, Small Defense Plants Administration, and Federal Civil Defense Administration. Included for ready reference are a subject index, a name index, a list of commonly used abbreviations for government agencies, and a separate list of officials from whom information may be obtained concerning additional Federal agencies.

HARAP, HENRY, director. *Free and Inexpensive Learning Materials*. Nashville, Tenn.: Div. of Surveys and Field Services, Geo. Peabody College for Teachers. 1952. 202 pp. \$1.00. Contains 2,521 entries of publications that cost 50 cents or less.

HARTFORD, E. F. *Emphasizing Moral and Spiritual Values in a Kentucky High School*. Lexington: College of Education, University of Kentucky. 1952 (Sept.). 93 pp. 50c. Presents the background and practical examples of how a program of emphasis on moral and spiritual value has been developed in a Kentucky high school.

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Home Economics for Boys and Girls in the Seventh, Eighth, and Ninth Grades. Misc. 3422. Washington 25, D. C.: Federal Security Agency, Office of Education, Division of Vocational Education. 1952. 56 pp. Because teachers and supervisors have repeatedly raised questions concerning the homemaking education program at the seventh-, eighth-, and ninth-grade levels, the Home Economics Education Branch of the U. S. Office of Education has collected and compiled descriptions of some promising practices at these grade levels in various parts of the United States.

How You Can Search for Science Talent. Washington, D. C.: Science Clubs of America, 1719 N St., N. W., 1952. 24 pp. Free. Sets forth the details of the Twelfth Annual Science Talent Search for the Westinghouse Science Scholarships.

Human Values in the Elementary Schools. Washington 25, D. C.: Dept. of Elementary School Principals of the NEA. 1952. 95 pp. \$1.00. What schools are doing and suggestions as to what they can do in the way of teaching those values that are basic for living in a democratic society.

HUNTER, GUY. *Residential Colleges.* New York 22: The Fund for Adult Education, 595 Madison Ave. 1952. 80 pp. 1 copy free. Discusses new developments in British adult education.

HUTCHINS, C. D., and MUNSE, A. R. *Federal Funds for Education, 1950-51 and 1951-52.* Washington 25, D. C.: Supt. of Documents. 1952. 100 pp. 30c. Answers questions regarding the Federal interest in education.

JOINT COMMITTEE ON EDUCATIONAL TELEVISION. *Television in Education.* Washington 6, D. C.: American Council on Education. 1952. 35 pp. A report of the Education Television Programs Institute held under the auspices of the American Council on Education at Pennsylvania State College, April, 1952.

JONES, LEO, compiler. *Curriculum Aids in Continuation Education.* Sacramento: Calif. State Dept. of Education. 1952. 111 pp. Describes some of the developments that have taken place in California's more than 30 years of continuation education.

JUNG, C. W., and FOX, W. H. *Extracurricular Activities in Indiana High Schools: General Program and Student Participation in School Government.* Bloomington: Indiana University Bookstore. 1952. 85 pp. \$1.00. A survey of the status of the extracurricular activities program in Indiana high schools.

KATONA, GEORGE, and LAUTERBACH, ALBERT. *The People Versus Inflation.* New York 22: Joint Council on Economic Education, 444 Madison Ave. 1952. 43 pp. Free. This resource unit on inflation is divided into two parts: (1) a section on content written by economists and addressed to the teacher; and (2) a section on study activities prepared by classroom teachers. Test forms and a list of reading materials, visual aids, and community resources are included.

Kindergarten for Your Child. Minneapolis: Office of Supt. 1952. 40 pp. This illustrated material describing the Minneapolis program was developed by a committee of kindergarten teachers, elementary-school principals, and some parents of kindergarten children, under the general direction of Arthur J. Lewis, assistant superintendent in charge of elementary education.

The Kremlin Speaks. Publication 4264. Washington 25, D. C.: Supt. of Documents. 1951. 40 pp. 15c. Excerpts from statements made by the leaders of the Soviet Union as compiled by the U. S. Dept. of State.

Labor and Industry in Britain. New York 20: Films and Publications Division, British Information Services, 30 Rockefeller Plaza. 1952 (Sept.). 40 pp. A quarterly review of economic and social developments, plus tables on Britain's economy.

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LANDIS, P. H., and STONE, C. L. *The Relationship of Parental Authority Patterns to Teenage Adjustments*. Bulletin No. 538. Pullman: State College of Washington, Agricultural Experiment Station. 1952. 32 pp. A study centered on evaluating the authoritarian and democratic family types as they affect the adjustments of teenagers. Based on questionnaire data pertaining to 4,310 high-school seniors—about one third of Washington state's high-school seniors.

LeCOUNT, S. N., and HARDY, L. L. *How to Study in High School*. Palo Alto, Calif.: Pacific Books, Box 558. A manual and workbook for student use.

Liberal Education at Massachusetts Institute of Technology. Cambridge: The Institute. 1952. 54 pp. Free. A description of the purposes and its general content.

LOWMAN, C. L., and ROEN, S. G. *Therapeutic Use of Pools and Tanks*. Philadelphia: W. B. Saunders Co. 1952. 104 pp. (7½" x 10½"). \$3.00. A text on therapeutic exercise as used in the water; presents theory and practice. Contains 196 diagrammatic illustrations.

MACKEY, C. L. *Planning the School Lunch Program*. Laramie: College of Education, University of Wyoming. 1952. 50 pp. 50c. Outlines a plan for the operation of a school lunch program in schools of various sizes.

MACMILLAN, D. L. *Outdoor Education*. Laramie: College of Education, University of Wyoming. 1952. 28 pp. 50c. Suggestions for helping groups plan outdoor education as a part of the school curriculum.

MARTIN, W. E. *The Teaching of General Biology in the Public High Schools of the United States*. Washington 25, D. C.: Supt. of Documents. 1952. 46 pp. 20c. This study reports on the courses in biological science offered in public high schools, enrollments in the course in general biology, and number of teachers of general biology. Covers also organization of the course, nature of the laboratory work, laboratory and supplementary facilities, the equipment and supplies, and innovations and problems related to the teaching of general biology. The findings are based on data collected for the school year 1949-50 from a representative sampling of the nation's public high schools.

Miami, Florida—An Example of the Effects of the Injection of Partisan Politics into School Administration. Washington 6, D. C.: National Commission for the Defense of Democracy through Education of the NEA. 1952 (Oct.). 47 pp. A report of an investigation requested by the President of the Dade County Classroom Teachers Association and the Florida Education Association.

Mutual Defense Assistance Control Act of 1951, Public Law 213, 82nd Congress. Washington 25, D. C.: Supt. of Documents. 1952. 111 pp. 30c. First report to Congress—a program for the denial of strategic goods in the Soviet Bloc.

OGG, ELIZABETH. *Preparing Tomorrow's Nurses*. New York 16: Public Affairs Committee. 1952. 32 pp. 25c. A report on a new study of current nursing needs.

The People Take the Lead. New York 16: American Jewish Committee, 386 Fourth Ave. 1952. 28 pp. 8c. A record of progress in civil rights, 1947 to 1952. Other publications available from the same source are: *What Is A Jew?* (3c each); *Are You Getting Good Neighbors?* (14 pp., 10c each); *This Is Our Home* (18 pp., 6c each); and *Community Is Good Business* (33 pp., 25c each).

Preparation for Tomorrow. Washington 25, D. C.: Supt. of Documents. 1952. 56 pp. 25c. The story of a German boy's year in America.

Publications of the Department of State. Washington 25, D. C.: Dept. of State. 1952. 56 pp. A semiannual list of available publications from the Dept. of State cumulative from January 1, 1951 to July 1, 1952.

SCHOONER, RICHARD. *In Love with Every Flower*. New York 1: William-Frederick Press. 1952. 44 pp. \$1.50. A collection of sonnets by this poet.

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SHAFFER, W. T. *Russian Communism vs. God's Communism*. New York 1: William-Frederick Press. 1952. 10 pp. 75c. A study in opposites.

SIMPSON, R. E. *A Teacher's Guide to the Education of Spanish-Speaking Children*. Sacramento: Calif. State Dept. of Education. 1952. 94 pp. Aids for the elementary teacher who has Spanish-speaking children in her classes.

STARR, CECILE. *How to Obtain and Screen Films for Community Use*. Evanston, Ill.: Film Council of America, 600 Davis St. 1952. 20 pp. 25c. Contains film information sources, sources of films for rental or loan, film agencies, a listing of major producers, tips on how to plan community screenings, and descriptive lists of films periodicals, sources of information about film and filmstrip producers, distributors, and libraries. Also included are suggestions on booking films for rental or loan as well as suggestions on purchasing films.

The Story of Safety. Wilmington, Del.: Du Pont de Nemours and Co. 1952. 28 pp. Free. Outlines the company's philosophy of industrial safety and shows how its policies and operations have made men safe at work.

Teaming Up for Public Relations. Washington 6, D. C.: National School Public Relations Association of the NEA. 1952. 48 pp. \$1.00. A handbook for leaders in American education based on recommendations of the National Conference on Public Relations in American Education, April 20 to May 1, 1952.

There Is Much to Learn. Fort Wayne, Indiana: Supt. of Schools. 1952. 68 pp. The 1952 report of the Supt. in text and pictures.

THOMAS, L. M. *A Handbook of Desirable Policies and Practices of Teacher Placement and Follow-up*. Laramie: College of Education, University of Wyoming. 1952. 36 pp. 50c. A report of a study.

The Three R's in the Elementary School. Washington 6, D. C.: Association for Supervision and Curriculum Development of the NEA. 1952. 161 pp. \$1.50. Contains descriptions of successful practices used by elementary teachers in guiding children in their understanding and use of these basic skills as a part of a sound program in the elementary school.

TYLER, E. N., and MORGAN, L. S., editors. *Health Educators at Work*. Chapel Hill: University of North Carolina, Dept. of Public Education. 1952. 115 pp. Vol. 3, 60c; Vol. 2, 50c; Vol. 1, 40c. Aids for health educators and others from allied professions in gaining a better understanding of the role of this new worker.

The UNESCO Story. Washington 25, D. C.: The U. S. National Commission for UNESCO. 1950. 112 pp. A resource and action booklet for organizations and communities telling the great scope of the work of this important agency.

VANCE, J. J. *Economic Education in the Junior College*. 1952. 78 pp. \$1.00. A proposed program of economics education as a part of general education in the junior college.

Veterinary Medicine as a Career. Chicago 5: American Veterinary Medical Association, 600 S. Michigan Ave. 1951. 16 pp. Free. Answers questions of high-school pupils who are considering veterinary medicine as a career.

VOORHIS, JERRY. *The Co-operatives Look Ahead*. New York 16: Public Affairs Pamphlets. 1952. 32 pp. 25c. Discusses 12 different co-operatives and problems and trends.

WATSON, G. E. *Guides to Curriculum Building* (Junior High-School Level). Madison: Wisconsin State Dept. of Public Instruction. 1950. 185 pp. (9" x 12"). An approach to curriculum appraisal and planning with the objective of helping teachers to harmonize curriculum offerings with the needs of youth. This is a publication that every junior high-school teacher who is sincerely interested in her pupils will want to have. A rich source of specific aids for better instruction.

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WINTERS, M. C. *Protective Body Mechanics in Daily Life and in Nursing*. Philadelphia: W. B. Saunders Co. 1952. 164 pp. \$3.50. This nurses' manual devotes Part III to fundamentals of anatomy, physiology, and physics which relate to posture and movement; Part II deals with factors which influence posture and body mechanics; and Part I presents application of principles of body mechanics. Contains 393 diagrammatic illustrations.

Your Child and Your School. Tulsa, Okla.: Supt. of Schools. 1952. 32 pp. A handbook for parents of children in the elementary schools of Tulsa.

Your Opportunities in Science. New York 20: National Association of Manufacturers. 1952. 32 pp. Tells the story of modern science and engineering, outlines specific jobs, and gives suggestions on selecting the job that best fits the individual.

Youth Views the 1952 Campaign. Des Moines, Iowa: Des Moines Technical High School. 1952. 16 pp. A project of the American problems classes of this high school.



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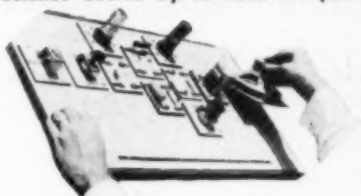
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News Notes

TELEVISION PROGRAMS.—An informal survey this fall reveals that 86 colleges and universities, 30 school systems, and five medical schools are producing television programs to carry on their work. This is not surprising inasmuch as the new medium is already revealing many uses which were not originally thought of when early evaluations were made several years ago. In addition, some 200 more institutions are equipping classrooms and laboratories to receive television or wiring to pick up programs from their own classrooms. Notable among these is the Harvard School of Business Administration which is equipping its new Aldrich Hall for just such purposes. Most significant at this time also is the response already made by universities and school systems to the opening up of the 242 channels which were set aside by the Federal Communications Commission last spring for the exclusive use of education on a non-commercial basis.

As of October 15, 1952, there were already 14 applications presented at the FCC for construction permits to operate stations. The locations and institutions were: *San Francisco*, (California), the Bay Area Educational Television Association; *Miami*, (Florida), the Lindsay Hopkins Vocational School, Dade County; *Manhattan*, (Kansas), Kansas State College; *Albany*, (New York), the New York State Board of Regents also *New York City*, *Buffalo*, *Rochester*, *Syracuse*, *Binghamton*, *Ithaca*, and *Utica* (all New York Board of Regents); *Houston*, (Texas), The University of Houston and the Houston Public Schools; *Los Angeles*, (California), the Allan Hancock Foundation at the University of Southern California; *New Brunswick*, (New Jersey), New Jersey State Department of Education at Rutgers University. In addition to these institutions, six applications have been filed for commercial channel assignments. Cornell University at Ithaca, New York; Loyola University at New Orleans; University of Missouri at Columbia, Missouri; St. Louis University at St. Louis; Michigan State College at Lansing; and Port Arthur College at Port Arthur, Texas.

The following have already received licenses to construct stations: Kansas State College, Manhattan; Allan Hancock Foundation at University of Southern California; University of Houston (and the public schools of Houston), New York State Board of Regents at New York City, Albany, Buffalo, Rochester, Syracuse, and Binghamton. Ithaca and Utica had yet to be acted upon and Poughkeepsie and Malone were awaiting engineering data before applying.

The New York state licensed stations represent the nucleus of a statewide network of educational stations to be operated by the Regents of the University of the State of New York, in co-operation with local school systems, private and parochial schools, local private and publicly supported colleges, universities, libraries, and many other educational organizations of that state. Similar state networks are being planned for Wisconsin, Iowa, Oklahoma, California, North Carolina, Connecticut, New Jersey, Pennsylvania, Illinois, Ohio, Utah, Alabama, and Texas. The Southern Regional Educational Conference will explore next month, at the meeting in Atlanta, the possibility of a Southern Conference network to serve the states it covers in its region.—U. S. Office of Education.

OUTDOOR EDUCATION FILMED—*Classroom in the Cascades*, a motion picture record of the Washington State Pilot Program in Outdoor Education, received its first public showing through television on KING-TV. The film, produced in sound and color, shows students of Highline High School living and learning in an out-of-doors setting in the Cascades as they work with their teachers and other resource people on conservation projects involving many of Washington's natural resources. The outdoor education project, conducted in May 1950, was planned by a state-wide committee of school and college people co-operating with the Highline school staff and representatives from various state depart-

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ments. Arrangements are being made to make the film available on request to school and community groups.—*Education In Washington*.

DOLLAR VALUE UPPED ON EQUIPMENT—Education construction self-authorized after May 1, 1953, will be allowed to use a DO rating authority for non-controlled building equipment up to \$100,000 and production equipment up to \$200,000 per project. This allotment symbol will be U-8. Schools will also be allowed to use their DO rating authority for the purchase of furniture, stoves, and refrigerators. The pinch will still come in the first quarter of 1953. The proposed relaxation was originally scheduled for April 1, 1953, but NPA Administrator Richard McDonald said he wanted to be sure that by the time the new relaxations went into effect the materials situation would permit orders to be filled. There is a good possibility that the situation will improve enough for the effective date of the relaxations to be advanced. Gymnasiums, swimming pools, stadiums, and other recreational facilities built by schools and colleges have either been prohibited outright or else permitted only after application to the NPA. The amended regulations will permit self-authorization for recreational construction after May 1, 1953, for amounts up to 5 tons of steel (not to include over 2 tons of structural steel), 500 pounds of copper, and 300 pounds of aluminum per project per quarter. Such self-authorization will also permit the use of DO rating authority for building equipment up to \$15,000 and projection equipment up to \$5,000 per project. The U. S. Office of Education is now handling applications from schools and colleges that wish to build recreational facilities of a type now prohibited. Until the limited self-authorization goes into effect in May 1953, this applies to *all* recreational construction proposed by education authorities. Such applications have hitherto been made to the NPA.

THREE-SPEECH RECORD PLAYER.—Responding to the need of industry, schools, and institutions for a very low-priced combination record player and filmstrip projector, Audio-Master Corporation, 341 Madison Avenue, New York City 17, announces creation of such a dual purpose combination which sells for \$89.50. Features of the phonograph are its 3-speed motor for playing 33 $\frac{1}{3}$, 45, and 78 rpm records, twist cartridge with two needles, loudspeaker, tone and volume control, and high fidelity amplifier. Also included are its 150 watt output, fixed-glass pressure plates with diagonal positioning which affords easy push-in threading, an 8-sprocket engagement which prevents tearing of the film perforations, automatic framing, forward or reverse, and coated anastigmat lenses. The audioscope is also available in combination with a transcription player with 8" loudspeaker, 5-tube amplifier, and a public address system. This unit is housed in the same portable case and sells for \$129.50. Both combinations can be had with a 300-watt filmstrip projector, stronger lenses, or DC operation at a moderate additional charge.

"AMERICAN SCHOOL CURRICULUM"—In this, the 1953 yearbook, the American Association of School Administrators considers the elementary- and secondary-school curriculum from the angle of the school administrator. For this reason it deals with the general objectives of the schools, patterns of curriculum organization, examples of new developments, the importance of teaching aids, home and community influences, the role of pupil learning and of the teacher's classroom methods, appraising the results, and ways to interpret the curriculum to the public. Much of the yearbook has been written for use by lay groups, such as PTA's and citizen committees. The volume, of about 374 pages, will include the up-to-date roster of AASA members. It will be sent free to AASA members in late January; sale copies will be available in the first week of February for \$5.00 per copy from the following address: American Association of School Administrators, 1201 Sixteenth Street, N. W., Washington 6, D. C.

NEW COLLEGE DEFERMENT TESTS—Selective Service Director Major General Lewis B. Hershey recently announced the dates for the next series of College Qualification Tests. The exams will be given on December 4, 1952, and April 23, 1953, at 1,000 testing centers across the country. More than 413,000 students have already taken the test, and

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some 190,000 deferred from service on the basis of test scores or class standards. General Hershey emphasized that increasing manpower demands make it important for each draft-eligible student to take the test if he wishes to qualify for deferment.

SECONDARY EDUCATION, 1950-2000.—Dr. Charles W. Sanford writes an article for the October 1952 issue of the *California Journal of Secondary Education* entitled "Secondary Education, 1950-2000." (pages 341-353) This article which discusses secondary education during the next half century is a rich source of facts, experience, and vision. "It is," as the editor of the *Journal* states, "the type of document that ought to be preserved for the record, and will surely be widely used by educators both in the colleges and universities and the public schools."

STATE NARCOTICS STUDY COMMITTEE.—A state committee on the study of narcotics was appointed by Dr. Lee Thurston, Supt. of Public Instruction, to think through the problem of narcotics and to come up with suggestions on what action should be taken, if any. The Michigan Secondary-School Association was represented on that committee. Dr. Vaughn Blanchard, Divisional Director of Health and Physical Education for the Detroit Public Schools, was elected chairman. A preliminary survey by Dr. Thurston of many school systems and some agencies disclosed that the number of school-age children involved was very small but that the problem was a serious one because it has the possibility of becoming more wide-spread and of developing an entering wedge into the school population. After deliberation the committee came up with the following suggested program:

1. Encourage by every means possible distribution of information concerning Enrolled Senate Joint Resolution F—a resolution which permits search and seizure in connection with narcotics drugs.
2. Prepare adequate instructional material for use in junior and senior high schools.
3. Prepare an administrative bulletin indicating possible procedures to be followed by school systems in connection with the administrative phases of the narcotics problem.
4. Have Dr. Thurston make available certain curricular materials regarding narcotics already developed by the Detroit public schools to other schools or groups.—*The Bulletin of the Michigan Secondary-School Association.*

A FILM ON THE IMPORTANCE OF MODERN EDUCATION.—Bradon Films, Inc., 200 West 57th Street, New York 19, New York, has recently released a new film entitled *Passion for Life or School of Life*. This motion picture shows how an inspired teacher dedicated to the responsibility of educating young people for citizenship can improve the life of an entire community. It tells the story of the achievements of modern education. The film was made in France by the Cooperative of the Film Industry as an entertainment film for theatre exhibition. It was shown with great success in Belgium, Sweden, Holland, Denmark, and other countries in Europe after its release in France in 1949-50 with the active co-operation of the Ministry of Education and the various national education and parent groups. It is based on a true story in Provence, France, after World War I, and particularly the work of Freinet. The film is available on a rental basis in either 16- or 35-mm. with sound. It is about 85 minutes in length. For complete information write to the above address.

LEARNING TO STUDY.—The Jam Handy Organization, Inc. 2821 E. Grand Blvd., Detroit 11, Michigan, has recently released a skit of seven filmstrips entitled *Learning to Study*. The titles of the filmstrips are: Study Headquarters, Getting Down to Work, Using a Textbook, Taking Notes in Class, Giving a Book Report, Writing a Research Paper, and Reviewing. These seven filmstrips help the teacher to present the basic points concerning study skills in an appealing manner. They provoke student thought and discussion. They serve as a starting point from which the teacher may expand the lesson with more detailed information to suit the needs of his particular class.



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FOREIGN AGRICULTURE MAGAZINE.—*Foreign Agriculture* is the only magazine in the United States that deals exclusively with the world's significant agricultural developments. This monthly magazine appeals to a wide range of readers, extending from the scholar and researcher, whose fields of interest are specialized, to teachers, students, and the casual reader, whose interests reflect natural curiosity about people in other lands. Send subscription orders to the Supt. of Documents, Washington 25, D. C., at \$1.50 per subscription per year.

REMOVING THE BLOCKS TO CURRICULUM IMPROVEMENT.—The 1952 yearbook of the New Jersey Secondary-School Teachers Association entitled *We Look at Curriculum Growth* in Chapter V (pp. 75-80) lists and discusses the following six blocks: (1) lag in community understanding; (2) the limitations of teacher training and experience; (3) barriers imposed by administrative policy and practices; (4) vested interests of professionals and organized groups; (5) lack of clear functioning of guidance personnel; and (6) limitations of the college entrance requirements.—*The Education Digest*.

TWO COMPREHENSIVE STUDIES BEGUN.—Plans have been formulated by the New York State Education Department, Albany, New York, and work has begun on two comprehensive research studies—one on elementary education and one on the junior high school. Both studies will be state-wide in scope and will seek to define desirable educational programs for New York State at these two educational levels. The junior high-school study seeks to bring about the maximum improvement in the state's program of secondary education. The research approach in this study is a three-pronged one to establish the basic facts upon which a fundamental reorganization of secondary education may take place; namely, (1) standards and practices in the better secondary schools through review of current literature, correspondence, and visits to secondary schools; (2) the characteristics of high-school pupils, emphasizing growth patterns and the nature of individual differences; (3) the impact of social and economic forces on education, including summaries of literature in the more important areas and research in a few areas where present knowledge is inadequate. Based upon the findings of these three approaches, suggestions will be made as to suitable programs for the junior high schools of the state.—*Bulletin to the schools*.

COLLEGE ENROLLMENT EXCEEDS EXPECTATIONS.—Early reports of fall enrollments received by the U. S. Office of Education indicate that pessimistic predictions made last spring of further decreases in college enrollment this year were not justified. It now appears that enrollment will be about the same as it was a year ago, although later reports to the Office may change the picture slightly. The most encouraging aspect of the situation is the increase of over-all freshman enrollment by 15 per cent. This increase has been reflected in the first-time enrollment of both men and women students. The increase is particularly notable in the smaller institutions. In some of the larger institutions, the over-all enrollment is not equally favorable. Robert Story of the Office of Education, who is gathering and analyzing the enrollment data, suggests that this is partly due to a falling off of graduate enrollments, particularly of veteran students. The smaller colleges without post-baccalaureate programs were the first to feel the decline of the veteran enrollment, which has not reached the upper levels of the educational program. Reasons for the increase in enrollment appear to be that the upturn in the birthrate of the Thirties is being reflected for the first time in more high-school graduates, that an increasing percentage of these graduates are entering college, that Selective Service still has not reached into the younger age groups for the

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draft, and that it has not modified its policy of deferment for college students.—*College and University Bulletin*.

WHERE TO ORDER MIDCENTURY REPORTS.—Two major publications of the Midcentury White House Conference and the few remaining phonograph records are now being sold by Health Publications Institute, 216 North Dawson St., Raleigh, North Carolina. The two volumes are both titled, *Children and Youth as the Midcentury*. One is subtitled, *Report on Youth, National Organizations, Federal Government*; the other, *Report on State and Local Action*. The price for each is 75 cents, or \$1.25 for the pair. Quantity rates are available. Health Publications Institute also sells the *Recordings of White House Conference Highlights* for \$10. Last report was that only 11 albums are available and no more pressings are contemplated.—*Progress Bulletin of the National Midcentury Committee for Children and Youth*.

COMMUNITY LIFE PUBLICATION—*How We Organize to Do Business in America* is the title of the recent joint publication by the Department of Rural Education of the NEA and the American Institute of Co-operation. The publication presents first of all how public schools were organized, then how a community is organized. It then describes the relationship of business to these two institutions. The booklet presents in graphic narrative form the methods by which the American people do business, the part their government plays, and the way in which various types of business organizations work together in the American system. The 36-page publication is attractive in an 8½ x 11-page size, with abundant, pertinent drawings to visualize the subject matter. The booklet may be obtained from the American Institute of Co-operation, 744 Jackson Place, N. W., Washington 6, D. C., for 35 cents a copy up to 100 copies, and 25 cents for quantities over 100.

BIOGRAPHY OF 900 TOP EXECUTIVES.—The November 1952 issue of *Fortune* magazine includes an article entitled *The Nine Hundred*. Nine hundred executives of the U. S. industry are the subject of this comprehensive report. It tells from where each came, how much schooling each had, what each earns, and how each rose to the top.

NATIONAL TEACHER EXAMINATIONS—The National Teacher Examinations, prepared and administered annually by Educational Testing Service, will be given at 200 testing centers throughout the United States on Saturday, February 14, 1953. At the one-day testing session, a candidate may take the Common Examinations, which include tests in Professional Information, General Culture, English Expression, and Non-verbal Reasoning; and one or two of eight Optional Examinations designed to demonstrate mastery of subject matter to be taught. The college which a candidate is attending, or the school system in which he is seeking employment, will advise him whether he should take the National Teacher Examinations and which of the Optional Examinations to select. Application forms and a *Bulletin of Information* describing registration procedure and containing sample test questions may be obtained from college officials, school superintendents, or directly from the National Teacher Examinations, Educational Testing Service, P. O. Box 592, Princeton, New Jersey. Completed applications, accompanied by proper examination fees, will be accepted by the ETS office until January 16, 1953.

A STAMP FOR THE NEWSBOYS.—The commemorative stamp honoring newspaper boys was launched with special ceremonies on National Newspaper Boy Day, October 4, when the stamp went on sale. To call attention to the child labor aspects of the newspapers' "little merchant" system for their carriers, the National Child Labor Committee has issued a statement. Following is a part of this statement: "The National Child Labor Committee is not opposed to part-time work for school boys, provided it is carried on under proper standards. Newspaper delivery is only one of the many opportunities for part-time work available to children and we believe that it should be subject to the same legal regulations as, for instance, delivery work for groceries or drug stores. Good laws usually set a 14-year minimum age for work outside of school hours and forbid early morning employ-

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THREE MILLION MEMBERS PLEDGE THEIR SUPPORT TO NATION'S SCHOOLS.—Some 3 million members of the American Legion through the delegate assembly of their recent national convention pledged themselves to defend the nation's schools against subversive attacks. "In recent years insidious forces both communist and reactionary," according to a resolution of the delegate body, "have sought to create in the minds of parents, taxpayers, and citizens general doubt and confusion concerning the integrity and effectiveness of our public schools by raising false issues and by sinister criticism and attacks upon teachers, administrators, and local boards of education." Asserting that "the ultimate objective of these attacks is the deterioration of our schools and the subversion of our American way of life," the delegates resolved:

"That the American Legion takes pride in the achievement of our public schools and recognize their importance and effective work in building and safeguarding the ideals of American citizens.

"That we condemn the authors of subversive attacks upon the public school whether they be dissident individuals or groups in the local communities, or inspired by evil forces, financed, directed, and operated by agents of subversion against our nation and against the American way of life.

"That we call upon every member of the American Legion to be on the alert in his community to know the schools and to recognize these attacks when they occur, and to stand ready to support and defend them against all enemies."

IOWA'S TELEVISION PROGRAM FOR SCHOOLS—Marking another milestone in Iowa television history, the state's three institutions of higher education and the State Department of Public Instruction, serving elementary and high schools, have undertaken a joint television project to bring to the classrooms of Iowa a series of programs for in-school viewing. Aired over WOI-TV, the Iowa State College television station, the Iowa TV School Time series is designed to supplement regular classroom instruction in the fields of elementary music, art and science, and secondary guidance. Subjects for the programs were selected early last summer at a meeting of school administrators at WOI-TV. At that time, school officials indicated that supplementary teaching in these specific areas would be of the greatest value in such a television series. The in-school programs are scheduled to continue throughout the school year at 10 A.M. Monday through Friday.

NEW YORK TIMES CURRENT AFFAIRS FILMSTRIP—South of the Sahara Desert live more than 150 million Africans and 3 million Europeans. It is about these people—the way they live, the way they work, and how they are ruled—that the New York Times current affairs filmstrip for December, *The Dark Continent Wakens*, is concerned. This 58-frame filmstrip is divided into four sections: (1) an introduction, showing the geography, the people, and the problems of Africa south of the Sahara; (2) living conditions and the problems of disease, poverty, and lack of fertile land; (3) development of Africa by Europeans and a survey of whether Europeans or Africans are benefiting from this development; (4) the governments of the area, which countries are home ruled, how much self-rule has been granted in colonial areas. It is illustrated with photographs, maps, and charts that present the subject in clear, graphic terms. A teachers' discussion manual, with an introduction to the

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topic and additional data on each frame, accompanies the filmstrip. *The Dark Continent Wakens* is the third of eight filmstrips in this season's New York Times Current Affairs Filmstrip series. The entire series of eight filmstrips is available for \$12.00; individual filmstrips are priced at \$2.00 each. They are available through the Office of Educational Activities, The New York Times, Times Square, New York 36, New York.

A NEW HALF DOLLAR IN CIRCULATION—It is the Carver-Washington commemorative half dollar honoring George Washington Carver and Booker T. Washington, two famous Negro leaders now dead. Congress authorized the minting of 3,000,000 of the coins, which show profiles of Carver-Washington, an embossed map of the United States, and the slogan "Freedom and Opportunity for All—Americanism." Exclusive right to sell them at a premium was voted by Congress for the Booker T. Washington Birthplace Memorial, a non-profit organization of Booker Washington Birthplace, Virginia, which has undertaken a nation-wide self-help and Americanism program for underprivileged American Negroes. Banks representing every state in the Union are selling the coins for \$2 each as a public service without fees or commissions and turning the proceeds over to the Memorial. The Memorial also sells collectors sets of three, one from each of the U. S. mints at Philadelphia, Denver, and San Francisco. These sets costing \$10 each, are obtainable by writing the Memorial organization at Booker Washington Birthplace, Virginia.


ATOMS AT WORK.—This 16mm sound film illustrates the many valuable peacetime uses of atomic energy available to mankind. Some of the strides made by England to harness this source of power for use in medicine and industry are shown here for the first time. Radio-active materials are shown being produced and put into use in hospitals, textile mills, and steel plants, including the complex machinery involved in the handling of these materials. This one-reel (10 minutes) film is available in black and white at a rental price of \$1.50 and a sale price of \$32.50 from the British Information Services, 30 Rockefeller Plaza, New York 20, New York.

BIBLIOGRAPHY OF FILMS ON CITIZENSHIP EDUCATION PREPARED—*Teaching Citizenship Through Films* is an annotated bibliography recently released by the Citizenship Committee of the National Education Association. Films are suggested for citizenship education in three areas: Activities of Childhood—The Foundation for Citizenship, Participating in Citizenship Through Youth Activities, and Citizens Working Together. The eight-page pamphlet sells for 10 cents. Orders may be sent to the NEA Citizenship Committee, 1201 Sixteenth Street, N. W., Washington 6, D. C.

VICTORY AT SEA—A series of 26 weekly half-hour film-and-music dramatizations on the history of naval operations of the ten crucial years during and after World War II has recently been inaugurated as a joint public service by the NBC television network and the United States Navy, on Sundays from 3:00 to 3:30 P.M., EST, (started Oct. 26). This series entitled *Victory at Sea* has been assembled from 61,815,000 feet of film from the files of ten different governments and twenty-six different agencies, including the extensive files of the Navy Photographic Center. Much of the film, including German and Japanese footage, will be seen for the first time, even by Navy personnel. The attack on Pearl Harbor, for instance, is seen largely through the eyes of the Japanese—the planning of the attack in Tokyo, the training of naval aviators and the mission itself. Submarine warfare in the Atlantic is seen partly through the eyes of German U-boat crews.

HIGHER EDUCATION ISSUES CONFERENCE REPORT—*Current Issues in Higher Education*, just released by the Association for Higher Education, a department of the National Education Association, is a compilation of the addresses, discussion-group reports, and resolutions of the Seventh Annual National Conference on Higher Education which was held in Chicago in April. The 146-page publication gives consideration to three major issues in higher education today—the financing of higher education, with the implications


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for the problem of current and future manpower demands; the role of higher education in strengthening the moral and spiritual foundations of modern society; and the attacks upon academic freedom and the traditional independence of colleges and universities. Single copies are \$2.00 with the usual NEA discounts on quantity orders. Requests may be sent to the Association for Higher Education, NEA, 1201 Sixteenth Street, N. W., Washington 6, D. C.

U. S. SAVINGS BONDS—The fall 1952 *School Savings Journal* has recently been released by the U. S. Treasury Department. This issue furnishes educators with information on the new and improved features of the Series E Savings Bond. An important statistical item is the table showing the sales of Savings Stamps for the last three school years. The trend has been upward; sales during the last school year were thirty per cent above those for the preceding year. For teachers seeking unusual material related to saving, there is an interesting, illustrated article on thrift habits among the Yakima Indians in the state of Washington.

AASA ISSUES GUIDE ON SUPERINTENDENTS' SALARIES—Business wise, the job of superintendent of schools may be the biggest administrative job in the community and should be compensated accordingly, says the American Association of School Administrators in a new pamphlet, *What to Pay Your Superintendent*, published jointly with the National School Boards Association. The 20-page publication suggests three general rules to boards of education on which to base salary decisions. Single copies are 25 cents with a discount on quantity orders. Requests may be directed to AASA, 1201 Sixteenth Street, N. W., Washington 6, D. C.

HIGH SCHOOL CENTENNIAL.—It was an important event in the history of secondary education in the United States when St. Louis opened the first public high school west of the Mississippi River on February 11, 1853. Originally called St. Louis High School, the institution became Central High School, now housed in the old Yeatman building, 3616 N. Garrison Avenue. The high school opened for business in the Benton School house, then situated on the east side of Sixth Street between Locust and St. Charles—this most central location was accepted as suitable for the temporary location of the high school. A plaque placed at 412 N. 6th Street by the Young Men's Division of the Chamber of Commerce in 1939 reads:

SITE OF BENTON SCHOOL

1842-1870

Here, in February 1853, a High School was opened and the first class of public high school west of the Mississippi was begun.

This is one of a series of Markers erected by the Young Men's Division of the St. Louis Chamber of Commerce, 1939.

In 1861, after the outbreak of the Civil War, the schools, including the High School, were closed for several weeks. The registration during the next four years did not increase. It is readily perceivable that the cause of this deficiency was the prostration of the entire school system. The recovery from this calamity was quite rapid in the lower grades, but the high school, which suffered most, and which it had required years of patient labor to acquire, recuperated more slowly. By 1865 the enrollment began to grow steadily. That year the graduating class contained twenty-seven members. By the year 1868, it was seen that the high-school had nearly recovered from the effects of the war.

In 1872, four branch schools were in use and were located as follows: The Polytechnic Building, on 7th and Chestnut Streets; the building on Christy Avenue, between 16th and 17th streets; The Peabody School building, on 18th and Carrol streets; and the Douglass School. The pupils were admitted into the branch schools upon the same terms and on the same standards as the former applicants were admitted to the high school.

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High School building at 15th and Olive streets was dedicated March 24, 1856. This building was erected at a cost of \$47,735.50, and was the first of its kind west of the Mississippi. The Tudor Gothic style employed in its design evidently set the pattern for all future high-school buildings in the city.

In 1893 the Grand Avenue building was completed. This building contained sixty rooms, of which eight were large study halls, each accommodating from 170 to 200 pupils. Thirteen hundred pupils could be seated in the new auditorium. The building was dedicated September 2, 1893. The January 1894 Class, numbering 62, was the first to graduate from the Grand Avenue building. The exercises were held at the Exposition Building.

In 1926 the school was housed in the Yeatman building pending the fireproofing of the Grand Avenue building. It was in September, 1927 that Central High School was moved back to its building at 1030 N. Grand Avenue. A fire broke out in the girls' gymnasium on the first day of school. Later this same month a tornado struck the central part of the city about 1:00 P.M., greatly damaging Central High School and causing the death of five girl students. In October, Central moved back into the Yeatman building and shared it with the Yeatman Intermediate School. The temporary move made in 1927 has been extended for a quarter of a century—to one-fourth of the life of the school.

Because of the significance of the founding of the high school, the Board of Education planned for the One Hundredth Anniversary of the opening of the school to be made the occasion of a Centennial Celebration. The following recommendations of a special planning committee have been approved:

1. That the Central High School Alumni Association arrange class reunions of all classes of the school together with a Centennial Dinner for all alumni.
2. That Central High School arrange a Centennial Program on February 11, 1953, for the present student body and the alumni and that they publish a special centennial edition of its yearbook.
3. That nation-wide recognition be received through contacts with the American Association of School Administrators, the National Association of Secondary-School Principals, and the activities of the local universities.
4. That all the St. Louis public high schools co-operate to produce a pageant of the development of the one hundred years of secondary education in St. Louis; that personnel of the St. Louis public schools write and produce this pageant; that this pageant be produced at Kiel Auditorium; and that a history of secondary education be published so that all records may be brought together and preserved for posterity.
5. That programs be arranged for production by Radio Station KSLH and other radio and television stations.

Central High School has indeed a unique and distinctive history. From its beginning it has been a compliment to the pioneer spirit of American democracy. Its graduates wherever they may be—and there are thousands—insist that "There will always be a Central High."

1953 AUDIO-VISUAL CONVENTION.—The 1953 convention of the Department of Audio-Visual Instruction of the National Education Association will be held in Hotel Jefferson, St. Louis, Missouri, February 24-28, 1953. The convention program will consist of general sessions, information and planning sessions, and a visit to the audio-visual center of the St. Louis public schools' extensive exhibits of new materials and equipment. Some of the topics to be discussed at the convention are: Role of Instructional Materials Specialists in Curriculum Development; Social Implications of Mass Media; What's New in State Programs; Programming for Educational TV; Accreditation of Schools and Colleges; Buildings and Equipment, County and Rural Programs; Instructional Materials; Radio and Recordings; Teacher Education; and Television in Education. For complete information write to the Department of Audio-Visual Instruction, National Education Association, 1201 Sixteenth Street, N. W., Washington 6, D. C.

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ILLINOIS MAP OF AUTHORS.—The Illinois Association of Teachers of English has prepared a large poster which is an outline map of the state showing interesting facts about Illinois authors, their place of activity, and a small picture in color exemplifying an outstanding activity in which each of the authors had engaged. The map was printed by Lithocraft Printers of Champaign, Illinois. A chart to the side of the map contains a list of the authors keyed to the pictures and names on the map. With each of the authors' names is the name of the chief work of the author and the date of its publication.

ECONOMICAL APPROACH TO ELECTRONICS EDUCATION.—A teacher owned company has just released the Thrift Model of its famous Dumville Electronics Educator. This is a small portable model of the famous large unit used by many graduate schools and requisitioned by the U. S. Department of Defense. It has been the dream of this company ever since its original organization in early 1951 to bring electronics education within the pocketbook of every school in America regardless of how small or how isolated. This unit which will perform the same experiments of this large unit, is available at a cost of less than fifty dollars.

The principle of the Dumville Electronics Educator is quite simple. The trainer simply uses a system by which individual components are mounted on special plaques which match identical green background as recommended by national sight conservation groups as the ideal color medium for visual training devices. The plaques by an entirely new system are almost effortlessly suspended for the view of the whole class. Attempt is not made in the Thrift Model to match plaque and background, since this unit is often used horizontally.

The factor that makes this electronics trainer so usable is mainly the speed with which the circuits can be assembled. One teacher built a regenerative receiver and amplifier—in less than ten minutes—this, in fact, from basic components such as tubes, socket plaques, resistors, *et cetera*. It is possible to build a two stage unit which means two step or amplifier with two tubes and networks in less than five minutes! A teacher can present a whole course in electronics plus using the board for many vital basic electricity demonstrations which is very adequate for the average high school with an outlay of less than fifty dollars. If he wants to go into the finer points of electricity, the company provides a basic electricity kit at a very small additional cost (called Kit A); if he wants the thrill of advanced circuits such as a superheterodyne receiver or high quality push-pull amplifier at small additional cost, he can buy Kit II; or if he desires to invade the fascinating field of transmission, he can buy Kit III. This feature of combining the best efforts of science and vocational experts in the development of the Dumville Electronics Educator makes it practical in its application in either department with valuable additions from each. That is why it is described as a training device and not a scientific device. In line with this, co-ordinated efforts of both science and vocational teachers are being summoned to aid in the development of advanced kits involving computer circuits, radar and lodar trainers, special industrial circuits, perhaps even television principles, and many other kits still in primitive development.

Any of the above kits may be added at small additional cost once the power supply and basic hanging board or cabinet are bought. The Thrift Model makes a fascinating "working book" that may be taken home by the pupil, hung on the wall of his room if space is limited and studied along with his homework in electronics by actual circuits which he can build not only for study but also for pleasure. His device can become both his radio and his phonograph amplifier with all the effects of adding a large 12-inch speaker. He does all of this without a drop of solder and can break down and use basic components over and over. The manual, which accompanies the Model, is only suggestive in character covering less than 65 experiments. The possibilities are almost unlimited in the variety of circuits which a pupil can devise.

Perhaps as a thorough educator the most valuable feature of the Dumville Electronics Educator is that the circuit when finally assembled on the board remarkably resembles the

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* Two copies of *Student Life* will be sent monthly to this address, eight times (October-May) during the school year. Enroll now.

The Seventeenth Annual National Conference of members of the National Association of Student Councils will be held in the Lincoln High School, Portland, Oregon, June 15-18, 1953.

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circuit shown in the drawing or schematic. This is all but impossible to accomplish with any other trainer particularly where the device constructs many circuits and not just one as customary for the traditional breadboard trainer. Many pupils are lost to the electronics world or driven to despair over the confusion found in the solder-ground-wiring-maze of the average chasis-solder system. The chasis-assembly method is still important, but it remains to be accomplished by pupils experienced at least in the fundamentals of electronics. It has been long recognized as poor educational practice to force pupils to master two techniques at once. It follows logically that a pupil should then master either soldering first or the practical understanding of electronics fundamentals. Since electronics fundamentals are so interesting and so highly motivating, it also follows logically that the tedious soldering technique becomes much less tedious when following rather than preceding the study of electronic fundamentals. Many a brilliant pupil is driven from electronics by a too early introduction to a soldering iron. The soldering iron is not the tool for a student; it is the tool of a mechanic as witnessed by the large groups of low I. Q. industrial workers who make the best soldering technicians.

This does not mean that the device was introduced to eliminate the valuable solder-chasis method of instruction but to precede it, to supplement it, and, when such method is begun, to parallel it daily while the solder-chasis method is being followed.

For teachers who wish to survey the possibilities of the Dumville Electronics Educator, the company has released its manual for examination for less than cost. Copies of the manual incorporating Kit I and Kit II may be obtained for one dollar from Dumville Manufacturing Company, Post Office Box 5595, Washington 16, D. C.

ERS OFFERS NATION-WIDE BENEFITS.—What is ERS? A source of practical assistance on school administrative problems. Operated jointly by the American Association of School Administrators and the Research Division of the National Education Association, the Education Research Service provides materials and services which, if assembled or attempted by individual school systems or institutions, would prove far more costly than a subscription to the Service. How much does it cost? Thirty-five dollars a year. What does a subscription include? It includes subscriber service, educational research service circulars, and selected publications. Information furnished promptly upon request. The files of the Information Section and library of the NEA Research Division, together with other sources available in the nation's capital, are drawn upon in answering requests from subscribers. Bibliographies, memorandums, and tabulations are often prepared. Publications of other agencies are supplied on a loan basis. Special reports prepared and distributed to subscribers eight to twelve times a year. Selected publications include yearbooks, bulletins, and reports of some of the major NEA departments, divisions, and committees. Publications of government and other outside agencies purchased for subscribers on the basis of timeliness and practical value. For additional information write to the Educational Research Service, 1201 16th Street, N. W., Washington 6, D. C.

CURRENT UNITED NATIONS PUBLICATIONS.—United Nations publications are on sale in the United States from the International Documents Service, Columbia University Press, 2960 Broadway, New York 27, New York. Write for the latest catalog.

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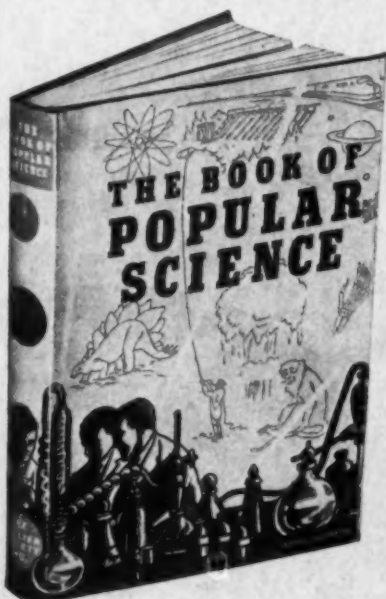
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